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Smart Grid Interoperability Use Cases for Electricity Storage Modeling within the IEC Common Information Model

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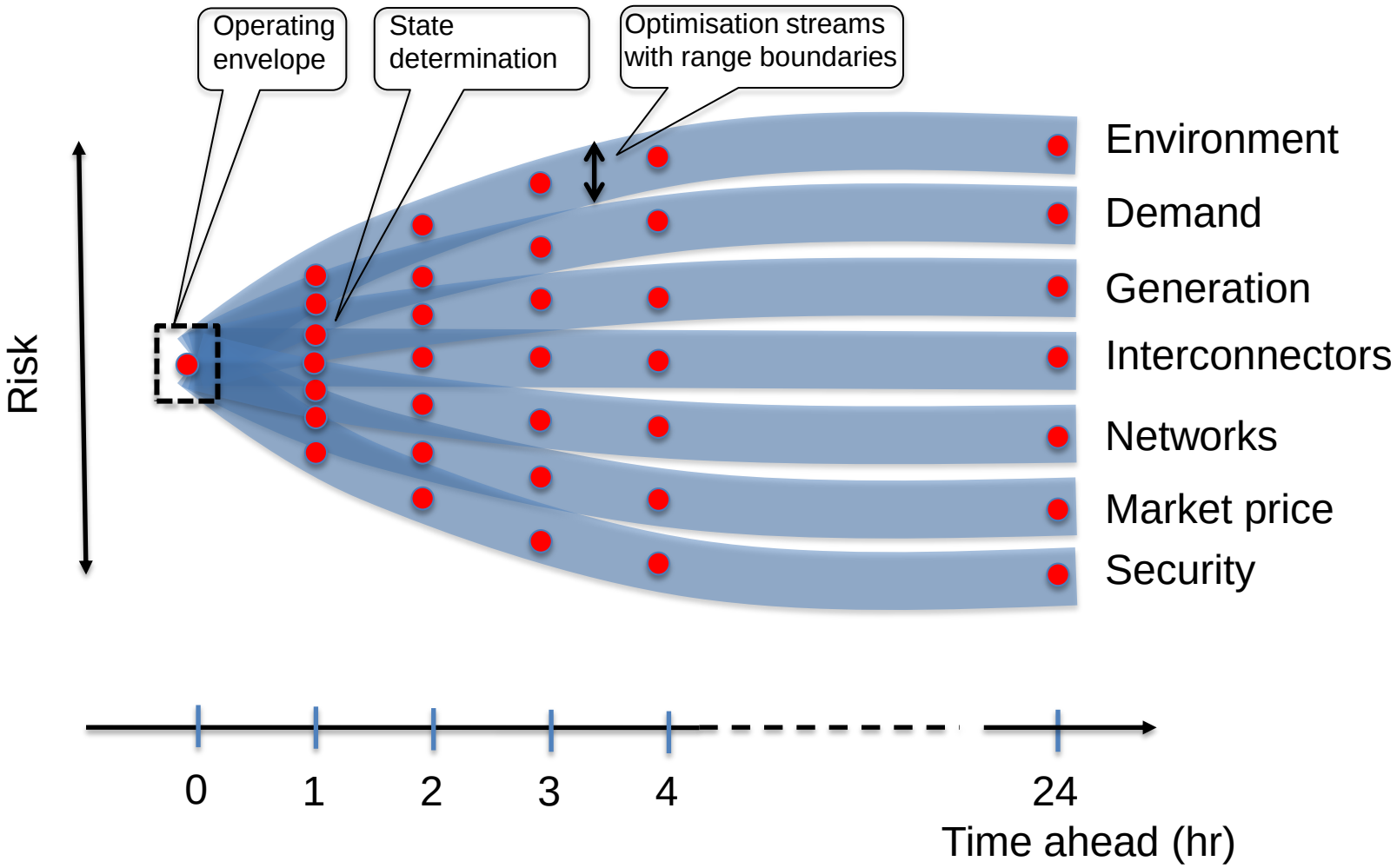
Overview – 2 parts

- Potential future smart grid operational vision
- Use cases & EES characterisation
- Current IEC 61970-301 energy storage architecture
- Proposed CIM energy storage model extension
- Energy security
- Conclusions & Further work

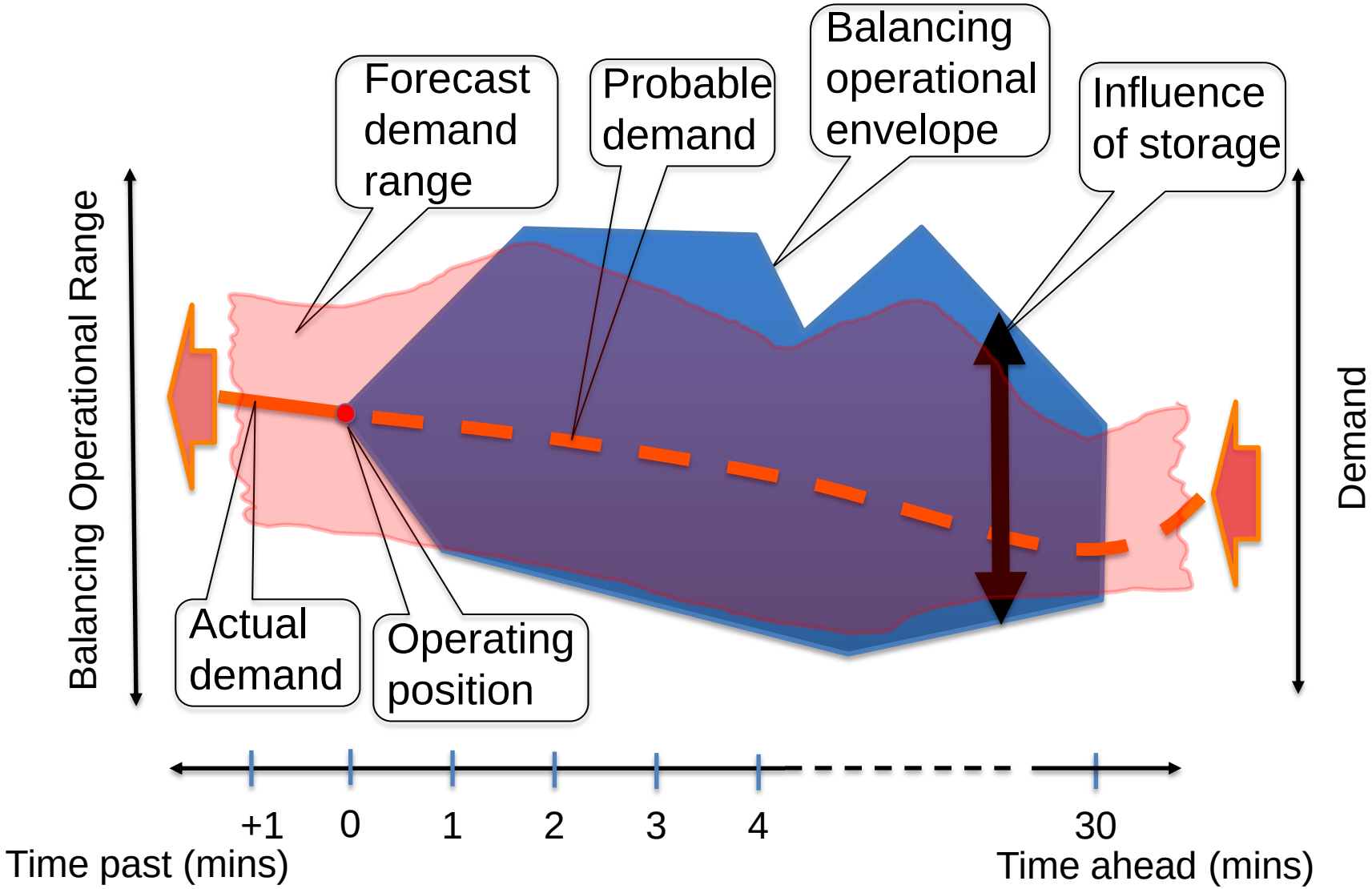
Two themes to consider

- Does the emerging reality of ‘non-pumped’, grid-scale electrical energy storage now warrant CIM extension?
- Is storage modeling another reason for CIM domain extension to further address the hydrocarbon domain?

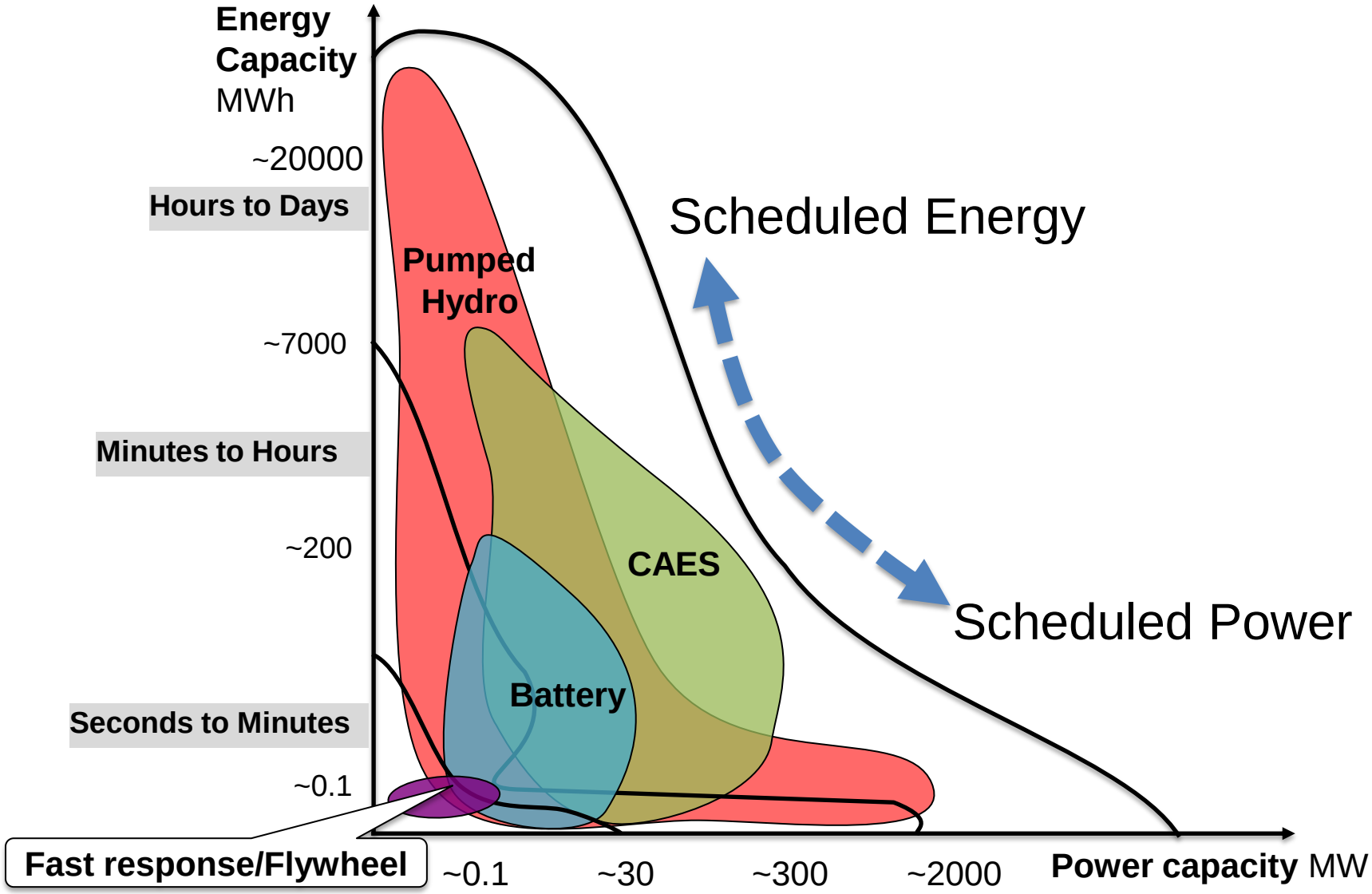
Operating future smart grids



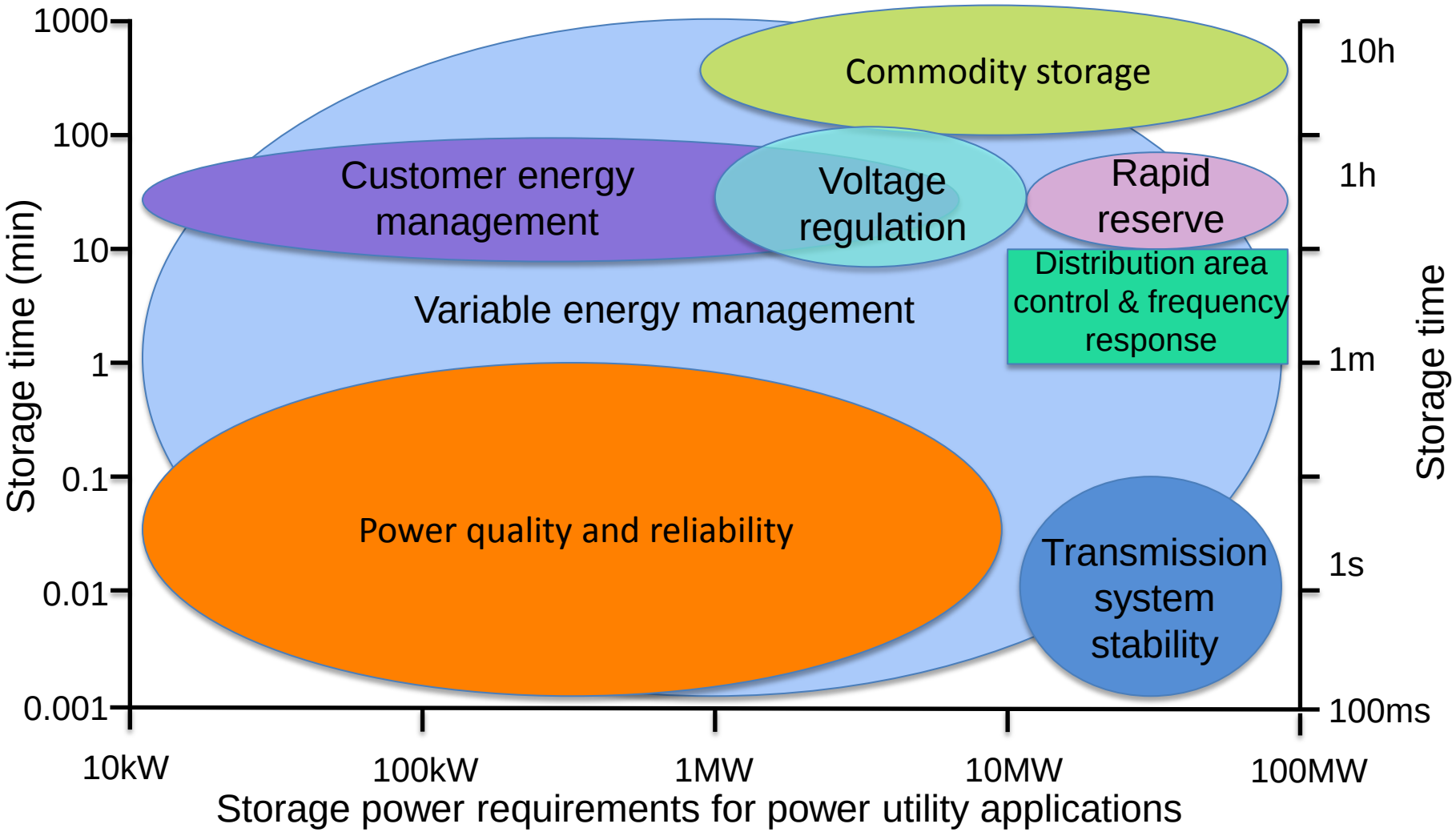
Storage in future balancing operations



Principal technology characterisation



EES use cases - Arbitrage & Reserve



Ref: ITM Power, Energy Storage Technologies

Principal technology marketisation

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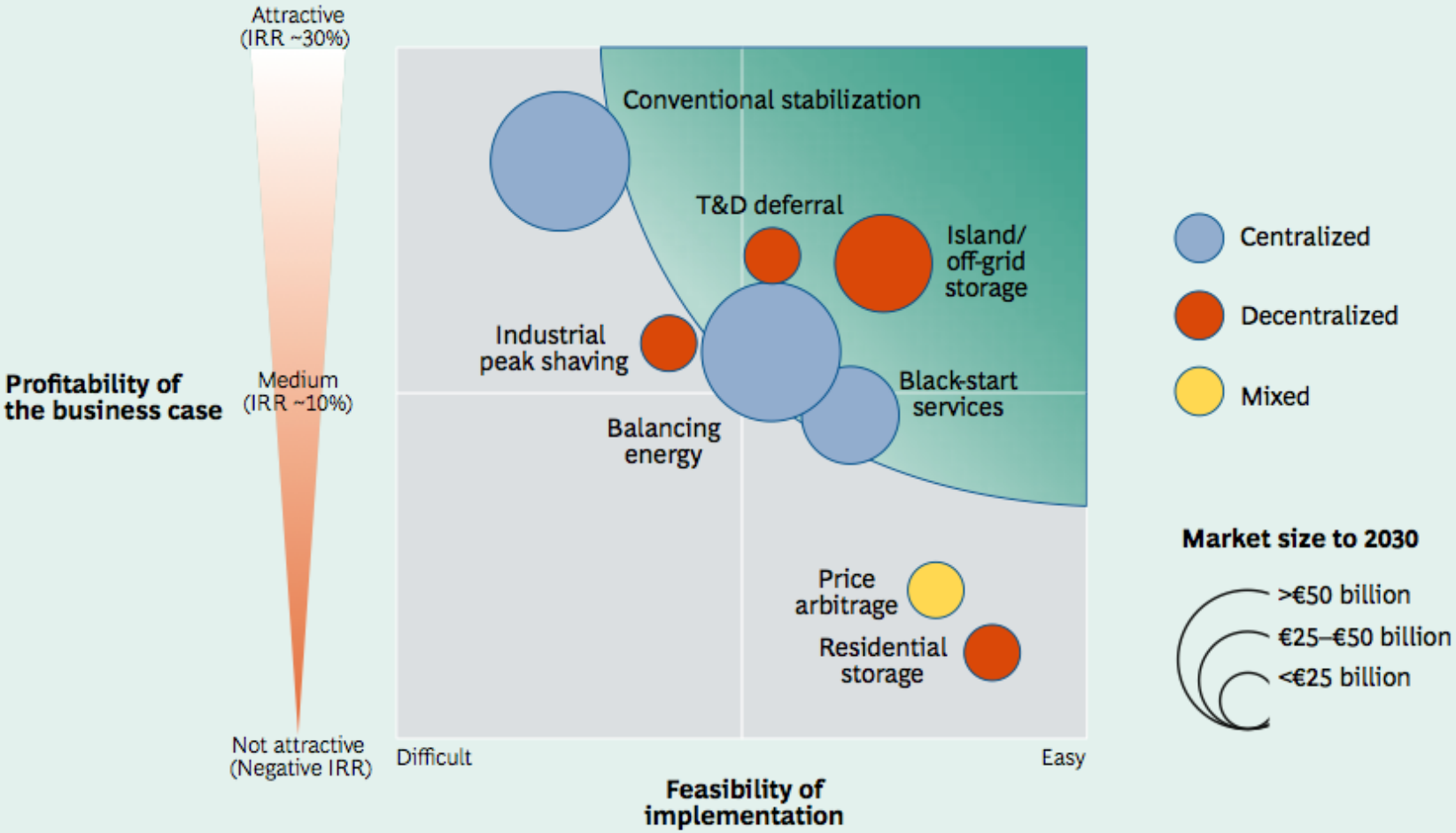
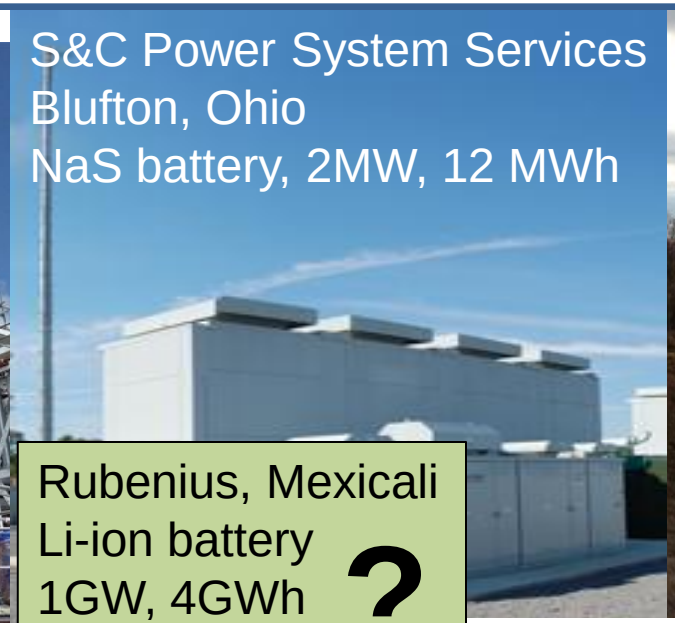
EXHIBIT 4 | Four or Five Storage Business Cases Will Be Attractive in the Near Future

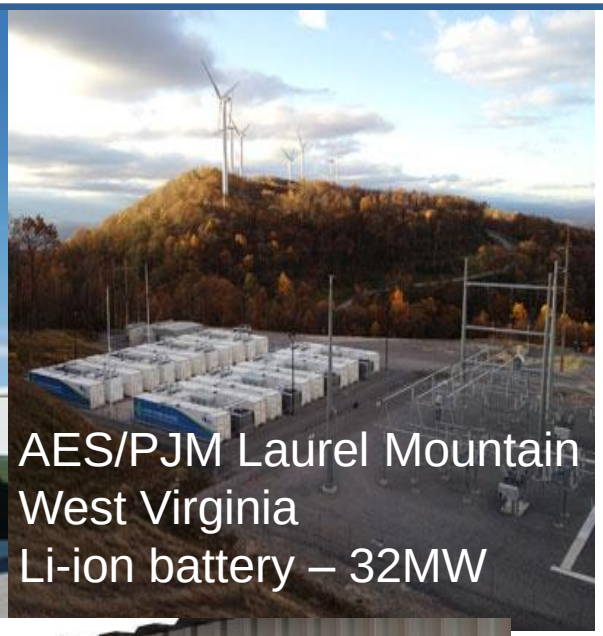


Calculations based on estimated storage prices for 2015–2020; price decreases would improve profitability in all cases

Source: BCG analysis.

Grid-scale connections, present & future





Rubenius, Mexicali
Li-ion battery
1GW, 4GWh
?

Announced

Energy storage systems take aways

Rosario Carbone, 2011 – Energy Storage in the Emerging Era of Smart Grids

- ESS are essential to higher levels of variable energy integration
- The renewable energy mix drives the type and capacity of reversible storage
- Increasing amounts of renewables and storage require coordinated operation
- Large hydro schemes can reduce the need for other reversible storage solutions

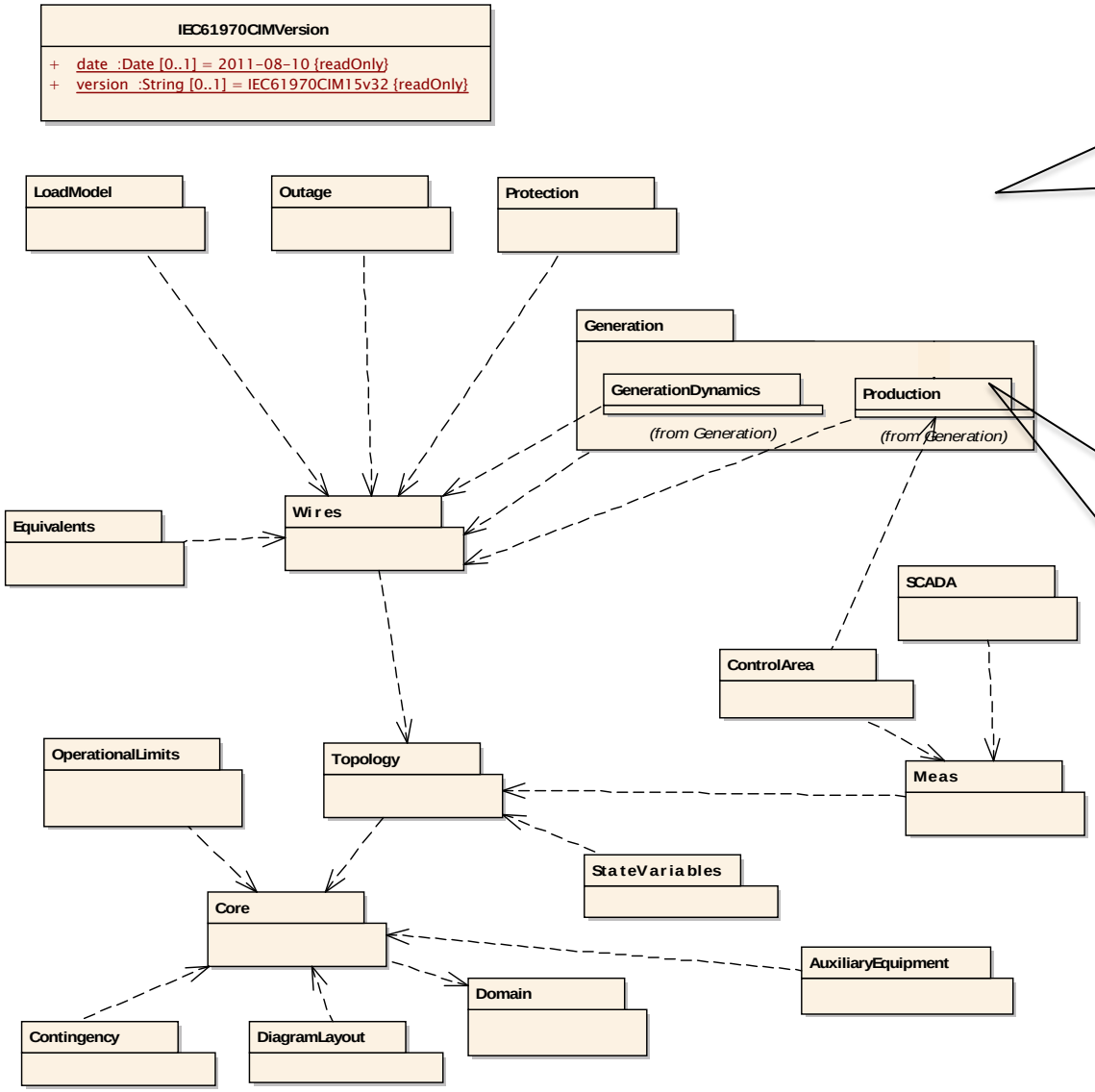
Imperial College, London, 2012 – Strategic Assessment of ESS in the UK

- Potential system savings increase as system decarbonises
- Can reduce generation investment cost
- Can offset the need for interconnection and transmission investment
- Distributed storage can reduce the need for distribution network reinforcement

Drivers for new storage model

- Decarbonisation & Energy Security
- Scheduled energy (despatchable generation, outage support)
- Regulating reserve (voltage and frequency control, power quality)
- Arbitrage (load-shifting, demand support)
- Stockpile and reserve modeling

Current IEC 61970 architecture



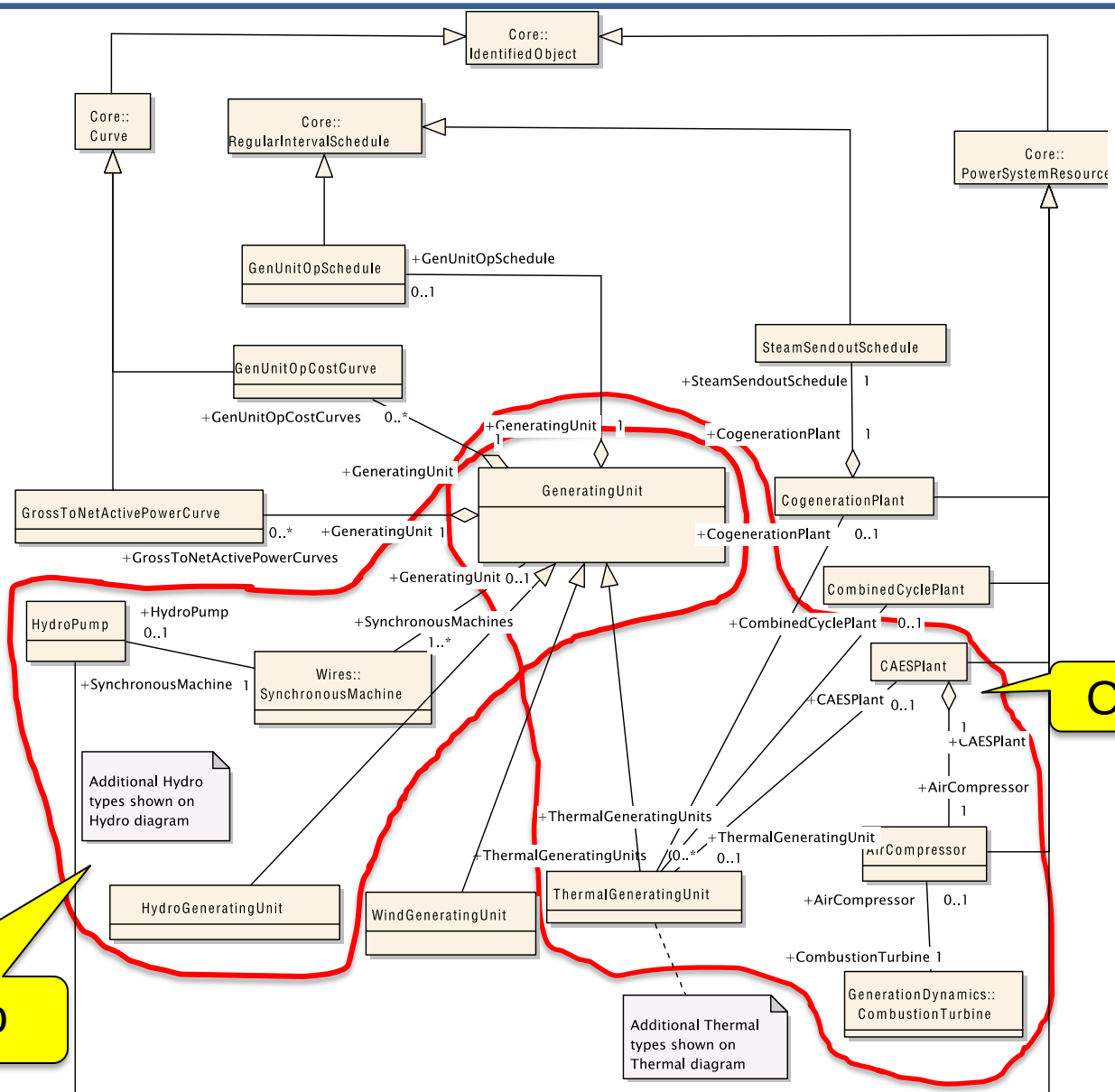
Proposed storage model contained in "Energy Storage" package

Current storage model contained in "Production" package

- Only addresses pumped hydro and air

Current IEC 61970 storage architecture

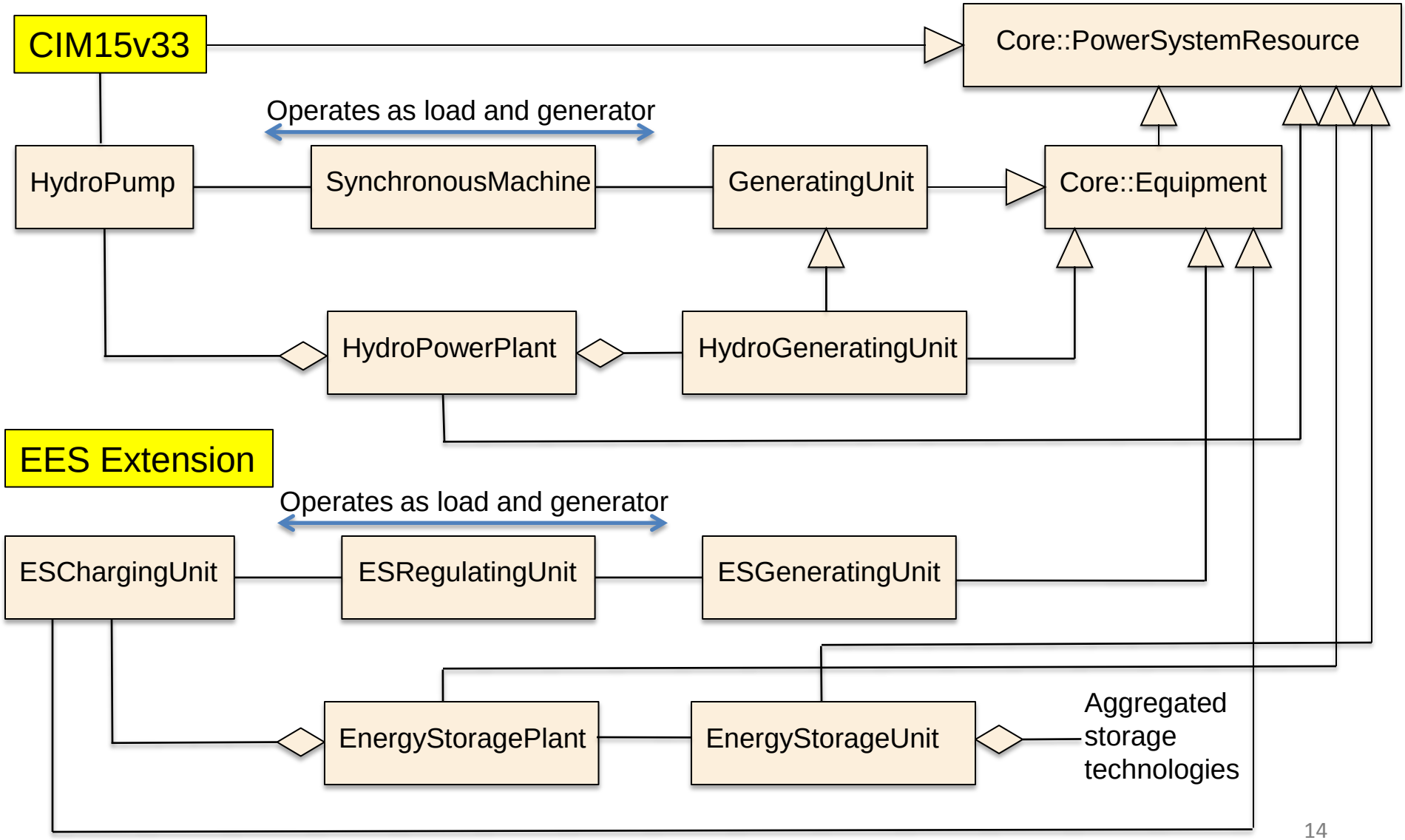
CIM15v33



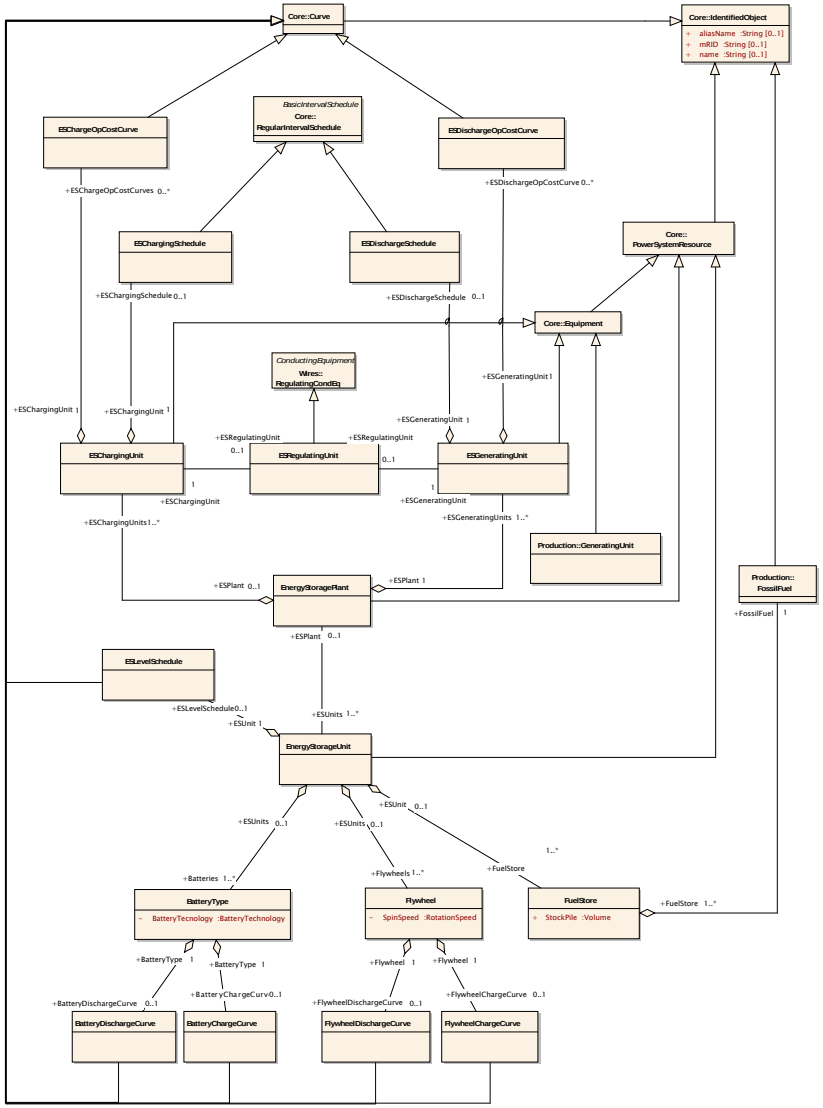
CAES

Pumped hydro

Current & proposed ES integration



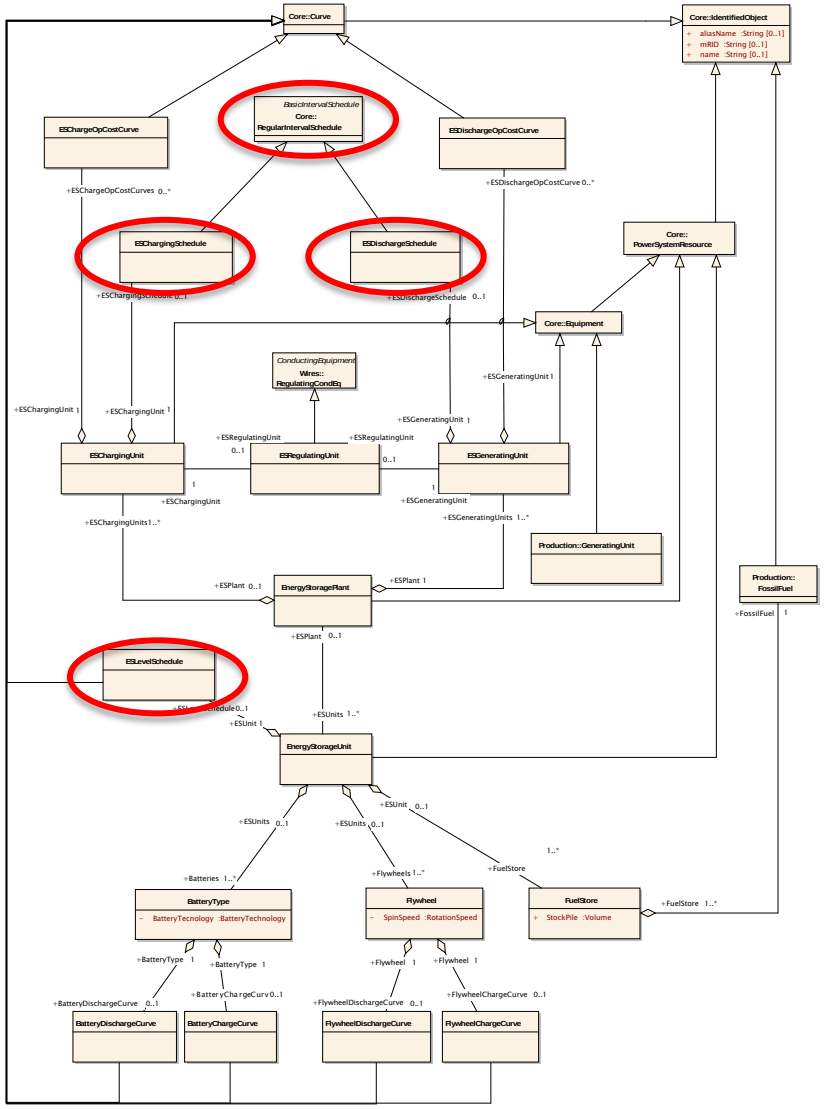
Proposed storage model composition



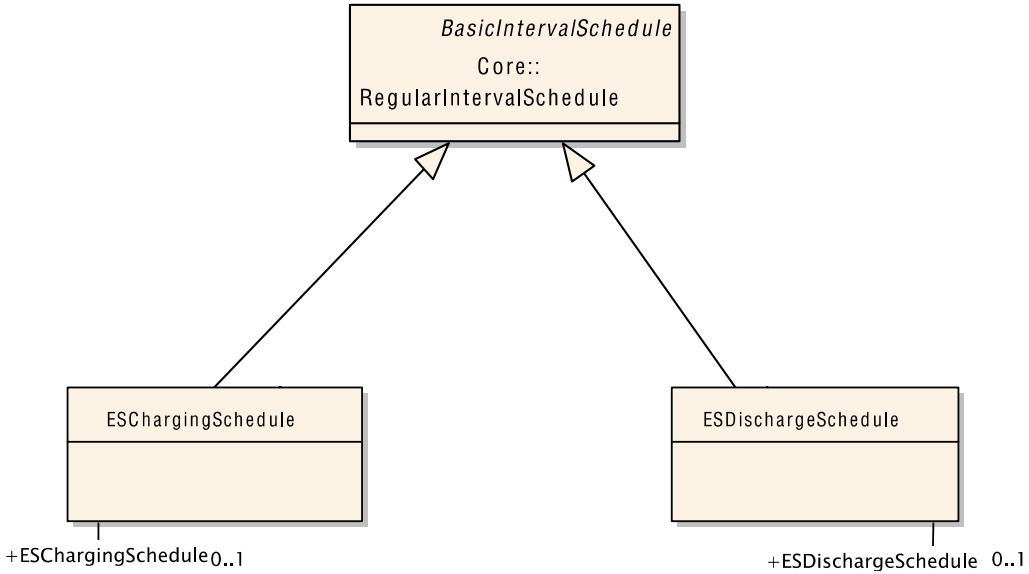
Abstract class objects

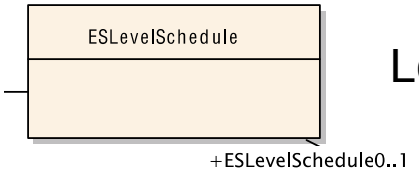
Concrete class objects

Scheduling



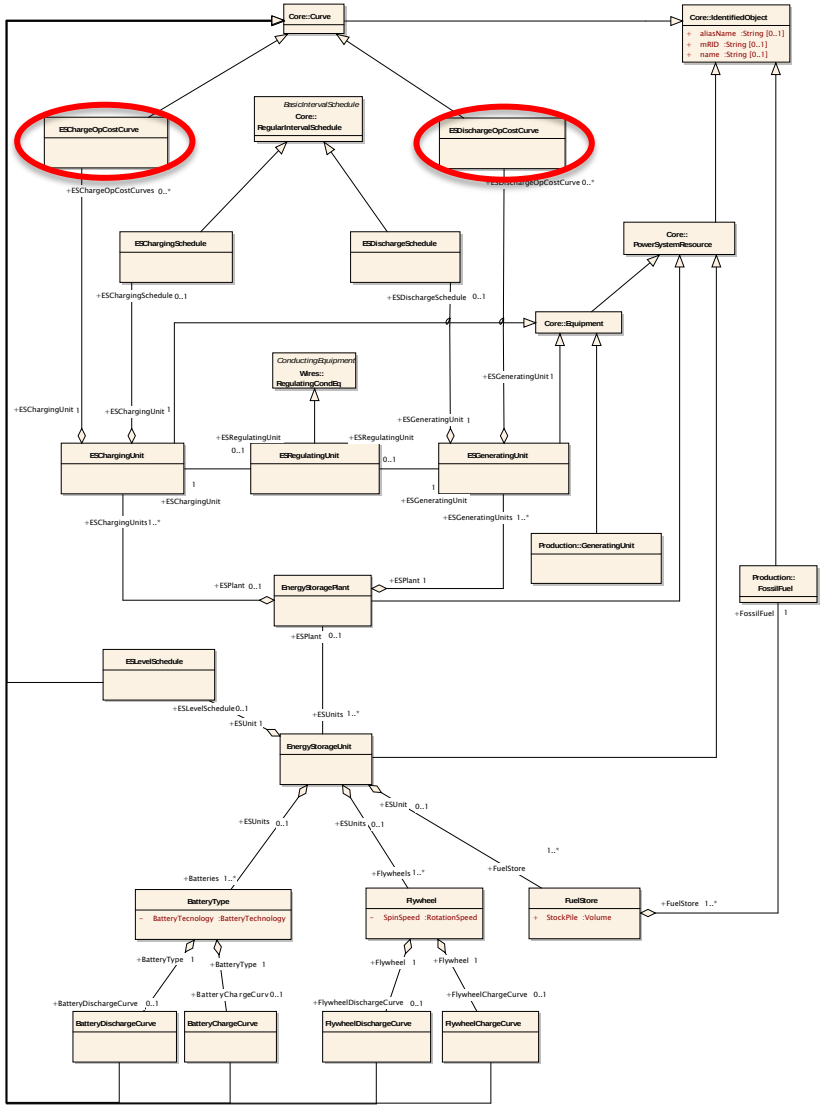
Energy scheduling

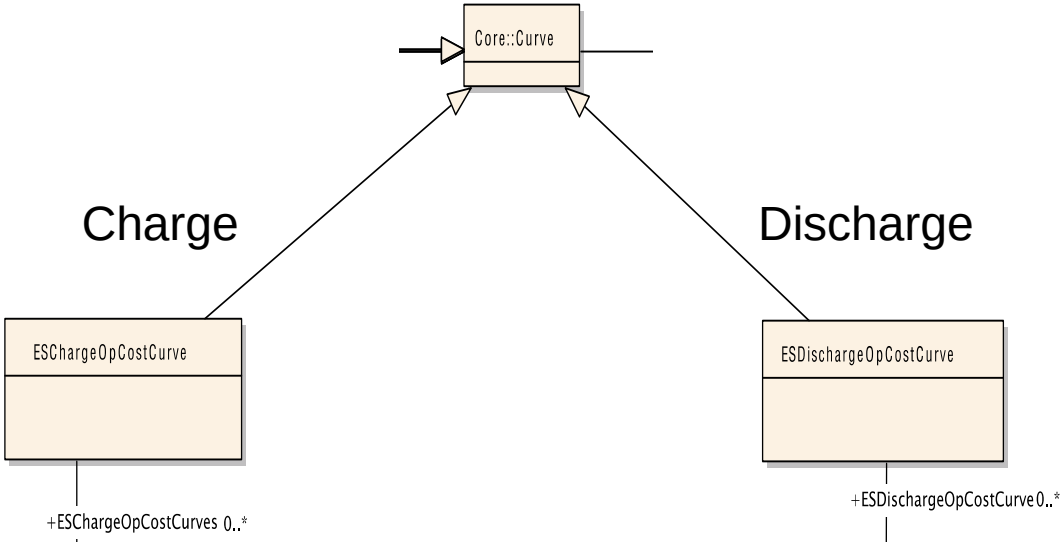




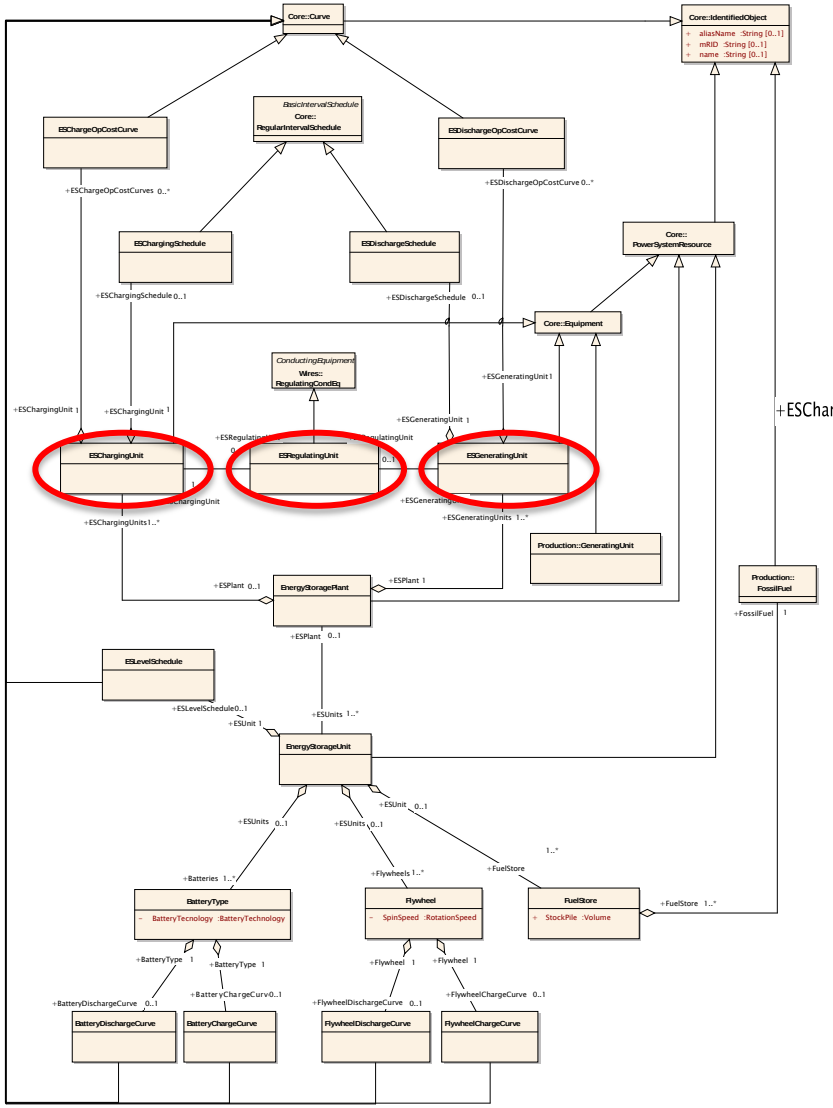
Level scheduling

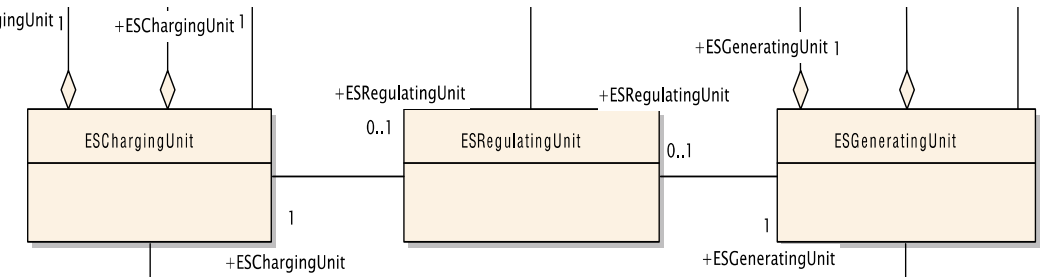
Operating cost curves





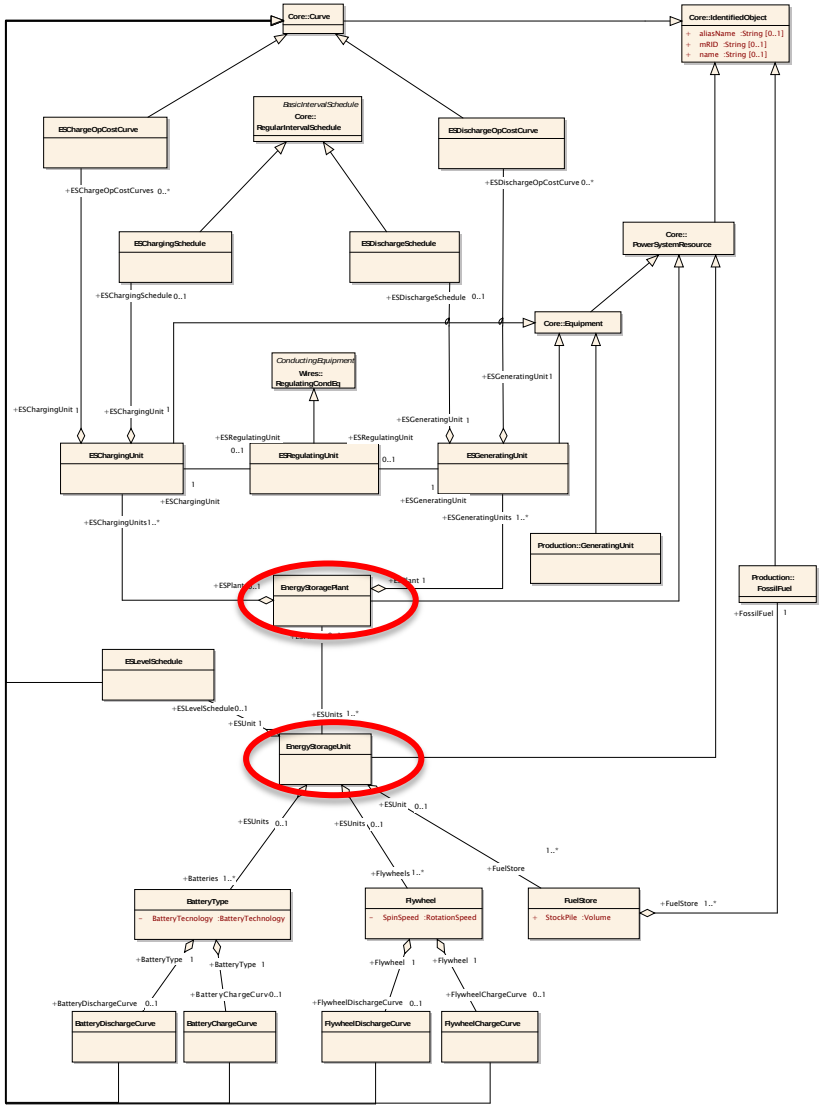
Operational mode characterisation



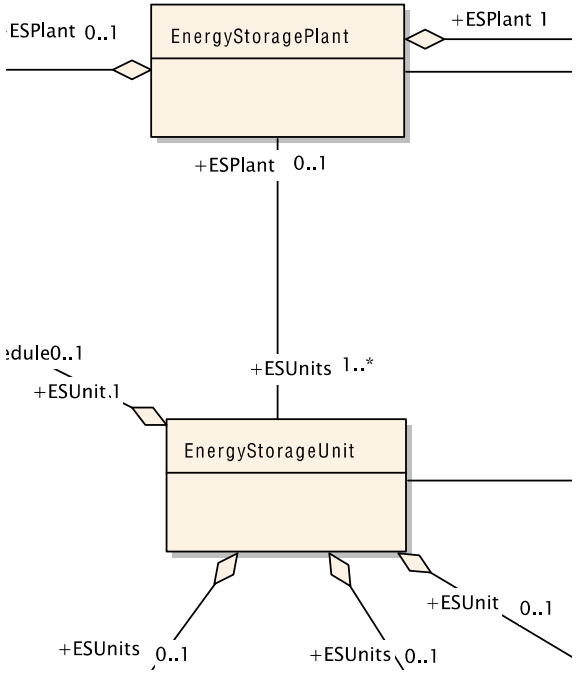


Charging Regulating Generating

Power system resources

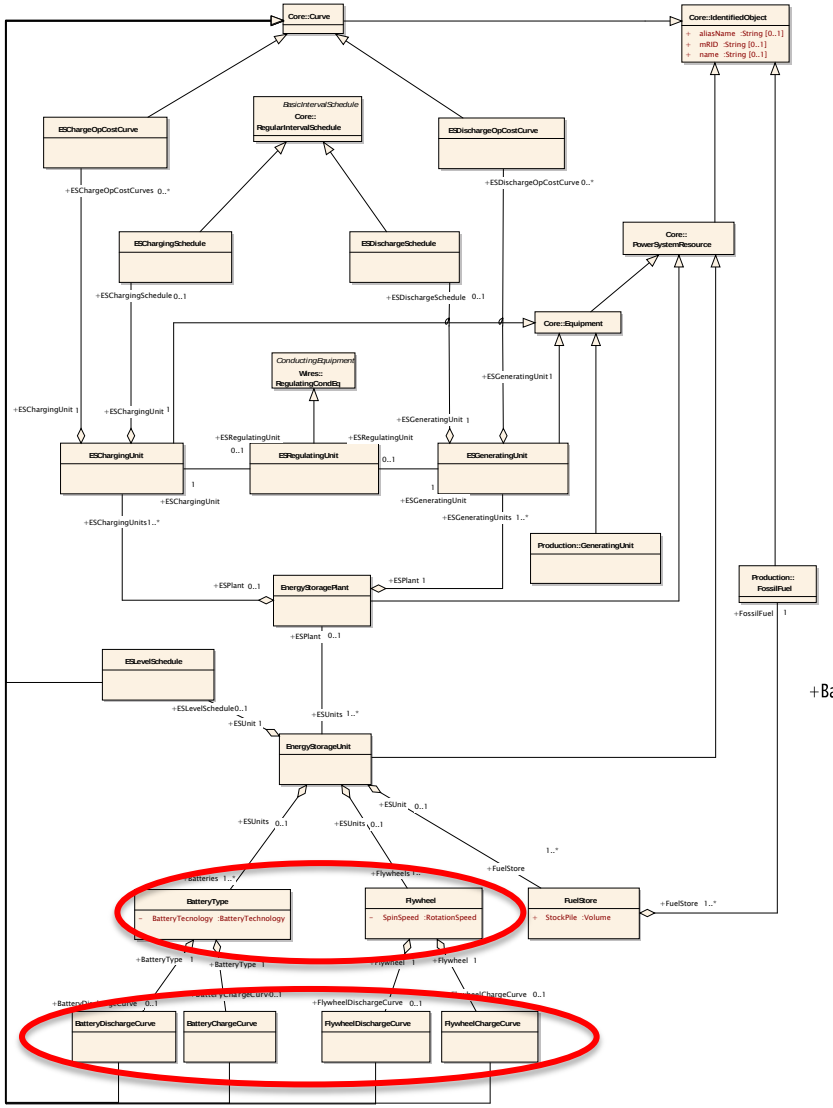


Bi-directional ‘switch’

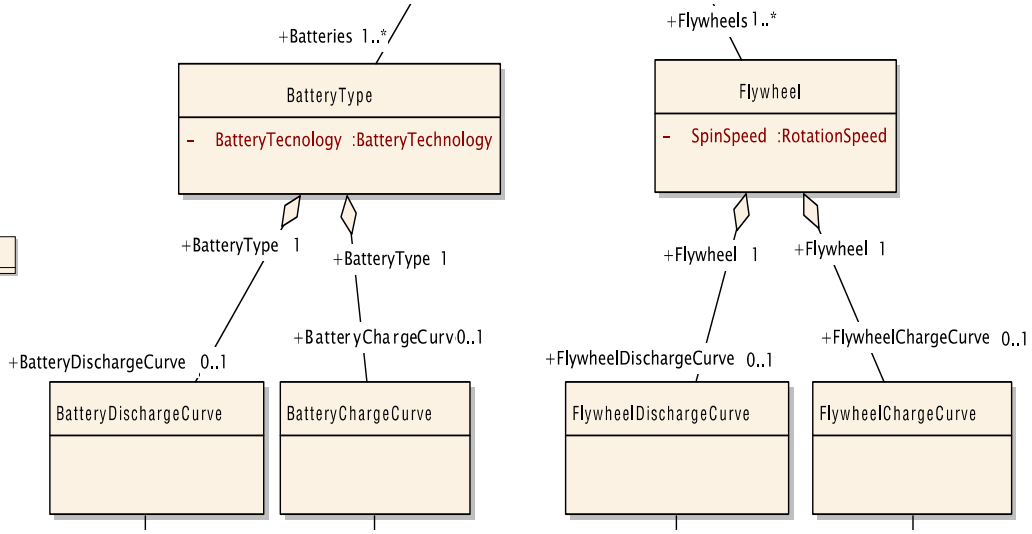


Equipment ‘container’

Technologies

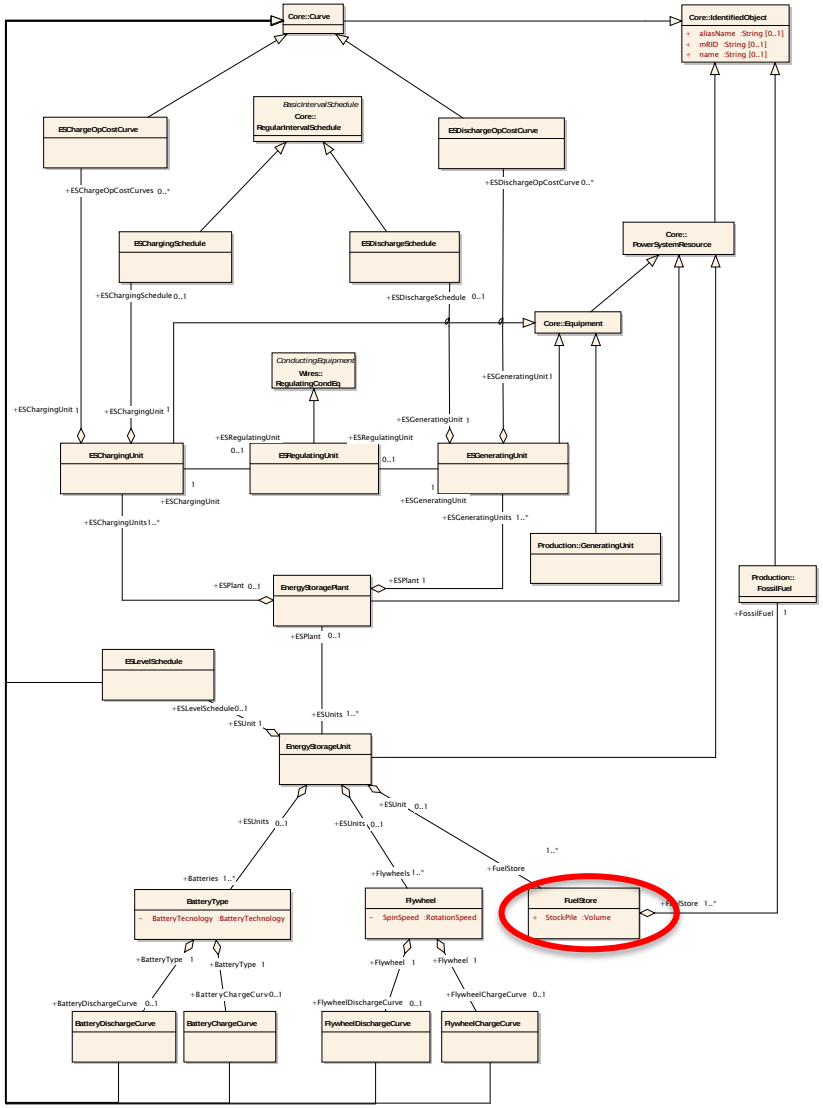


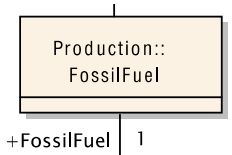
Equipment technology



Technology curves

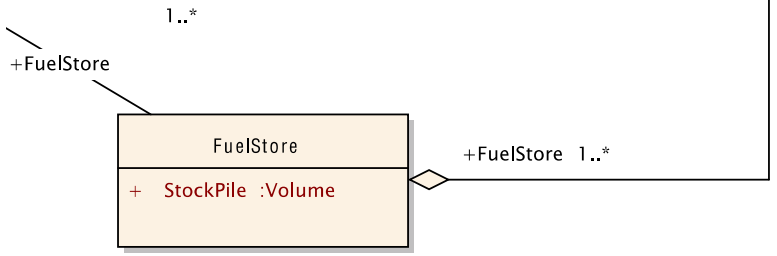
Energy stores (security)





+FossilFuel 1

Fuel Store
(depots, reserves, unrecovered)



New class extensions

11 New Classes	Function
EnergyStorageUnit	Equipment container for different ES technologies
EnergyStoragePlant	Determines ES technology mode of operation
ESGeneratingUnit ESChargingUnit ESRegulatingUnit	Modes of operation
ESChargeSchedule ESDischargeSchedule	Manages scheduled ES use cases under RegularIntervalSchedule
ESLevelSchedule	Helps determine the operational status of a given technology
ESChargeOpCostCurve ESDischargeOpCostCurve	Cost curves provide data for ES operational optimisations
FuelStore +StockPile	Aggregates stock-piled energy and fuel reserve resources

Sub-classes would also be required to identify and control ES technologies

CIM scope as *energy* domain model?

- Why limit to decarbonisation use case?
- Energy security includes energy storage
- Energy resource model looks at reserves
- “FuelStore” class addresses fuel stockpiles
- Is this a ‘bridge’ to gas model extension?

Conclusions & Further work

- ES model looks to smart grid energy modeling needs
- Proposed extension supports class re-use
- Integrates with existing CIM architecture
  - Determine attributes & enumeration classes
  - Definition of use cases to IEC 62559
  - Harmonisation with other IEC standards & TCs (IEC 61427-2; new IEC EESS TC)

Thank you for you attention

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