Regulation and Innovation: The case of Advanced Energy Storage

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Background

- Studies on new public management, alternative service delivery and reflexive regulation in public goods regulation
  - Public Safety (DAAs)
  - Railway/transportation safety (reflexive, meta-regulation)
- Network on Energy Storage Technology (NEST)

Background

- Potential tensions between “agile,” “flexible,” regulation and public goods

  – Boeing 737 Max

  – Railway safety (Lac-Megantic) and other events.

- How much of a problem does public goods regulation present to innovation?

Case Study: Advanced Energy Storage

- Network on Energy Storage Technology (NEST)
  - 5 Year NSERC Strategic Research Network
  - 4 research streams
    - 3 technical
    - Stream 4: Economic, Policy and Social dimensions of advanced energy storage development and deployment

NEST Project 4.5 Goals:

- Assessment of the existing regulatory and policy frameworks in leading jurisdiction as they relate to the development and use of energy storage technologies.

- Make recommendations regarding policy frameworks for Canada to advance the further development and deployment of energy storage technologies in an environmentally and economically sustainable approach in the electric grid.

Energy Storage Technologies

Electrical Energy Storage Systems

Mechanical
- Pumped Hydro - PHS
- Compressed Air - CAES
- Flywheel – FES

Electrochemical
- Secondary Batteries
  Lead acid/NiCd/NiMh/Li/NaS
- Flow Batteries
  Redox flow / Hybrid flow

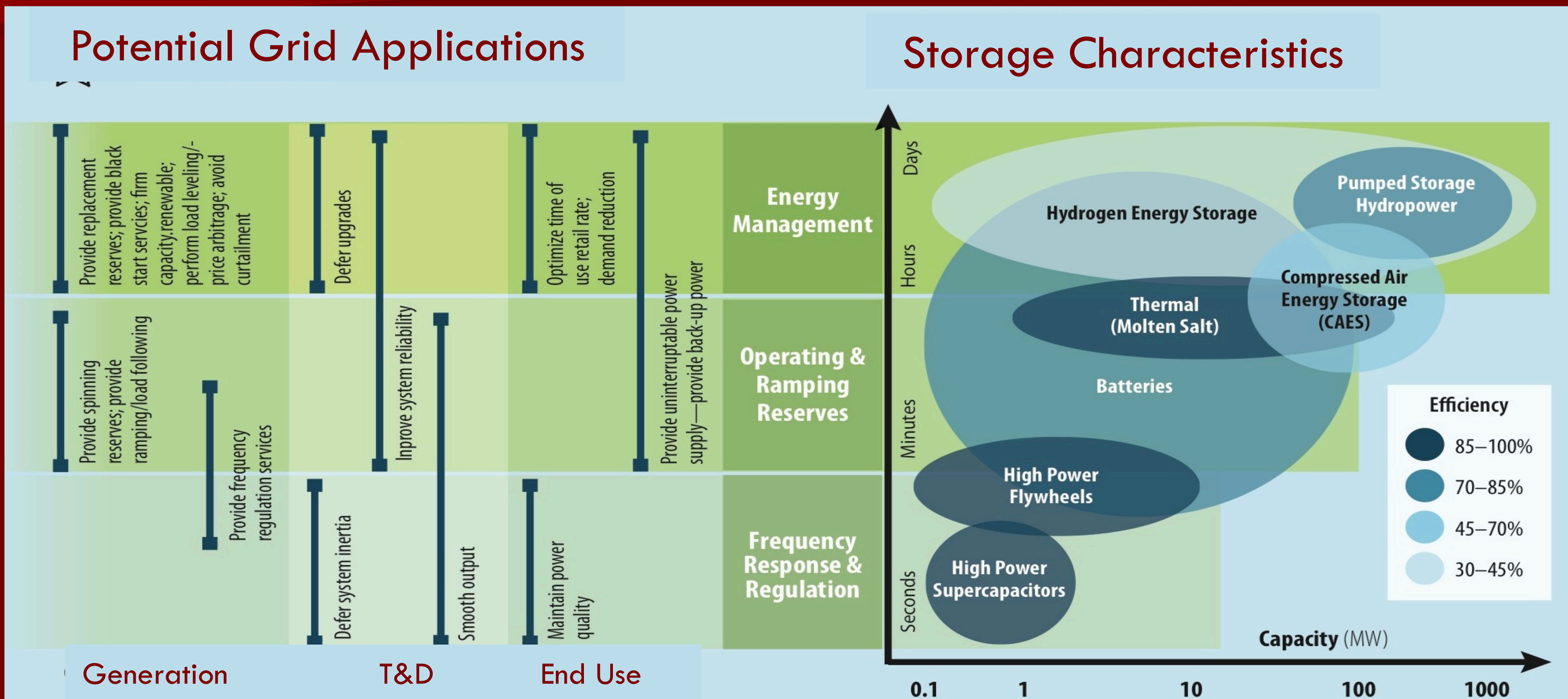
Chemical
- Hydrogen
  Electrolyser / Fuel cell / SNG

Electrical
- Double-layer Capacitor
  DLC
- Superconducting Magnetic
  Coil - SMES

Thermal
- Sensible Heat Storage
  Molten salt / A-CAES

Reproduced from IEC 2011

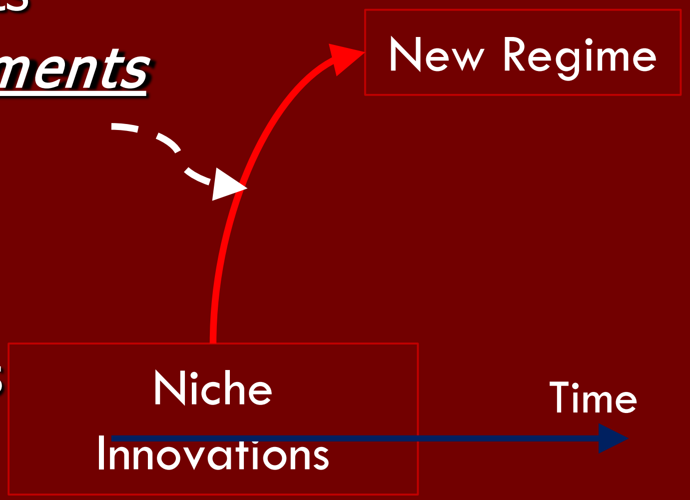
Potential Applications:



From NREL 2016

Theoretical Framework: Socio-Technological Transitions

- Modern Storage as niche level developments
  - Propelled by ***landscape level developments***
    - Smart Grids
    - DG/BTM Activity
    - Large-scale intermittent renewables
    - Developments in storage technologies



  - Now encountering existing policy, regulatory, technological and institutional regimes

Research Methods

- Literature reviews
- Informal discussions and formal interviews with industry, government, key informants
- Attendance at industry workshops/conferences in US (ESA), Canada and UK
- Hosted workshops with speakers from Canada, US, UK, EU.
- Outputs: working papers on SEI website, formal papers in *Energy Policy, Energy Regulation Quarterly*

Key Findings

- Key Barriers are <u>not</u> in the realm of public goods regulation (health, safety, environment, land-use planning)
  – Virtually never arose in five years of engagement with industry in Canada, US and EU as barrier to development and deployment of technology
  – Extent to which issues raised they relate to the absence of regulatory regimes/rules (fire safety, land-use, end of life for battery technologies)

- Key barriers are in the realm of economic regulation

Market Challenges

- Technology maturing; private capital interested, but struggling to find sustainable economic model.
  - Existing activities via mandated procurements
  - One-off projects, pilots, special markets

- Key barriers embedded in market rules (the regime)
  - Market design before ESS and other new technologies existed/contemplated
    - (thought design technologically neutral but in encounters with new technologies it emerges that it is not).

Market Challenges (FERC, OEB, Germany, Alberta)

- Recognition as market participant
- Technical Barriers/Bidding Characteristics
  - Size, period of operation
- Ability to play multiple roles/provide services to multiple markets (generator, consumer, DR/DSM, ancillary services, capacity/balancing) not recognized/accommodated
  - Undermines multi-role business cases
- Lack of rules around distributed resource (DER) aggregation
  - Who can do aggregation?
  - How paid?

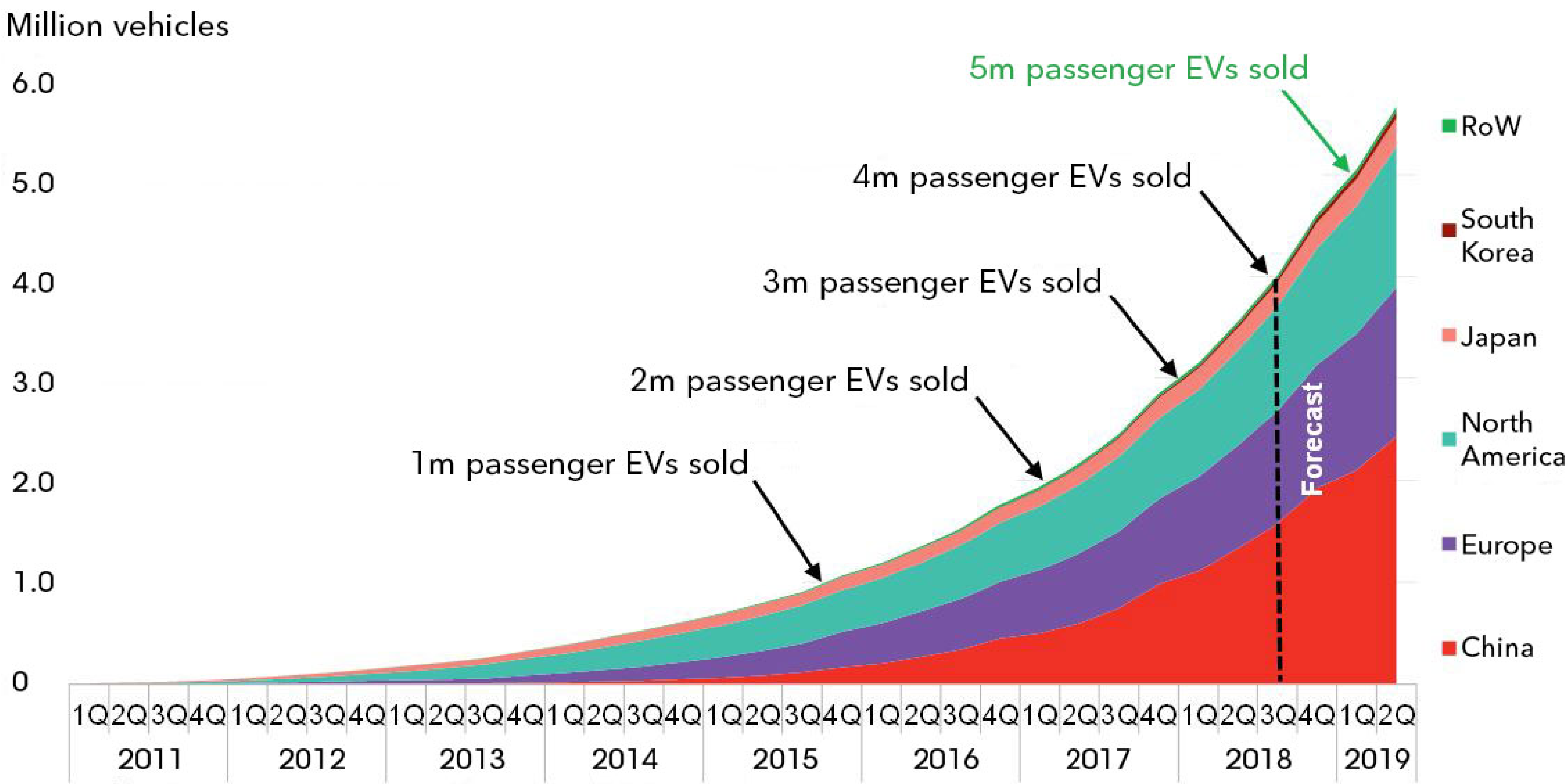
Market Challenges

- Conceptual barriers around role of "technological neutrality"
- Ownership and control of storage resources by utilities, RTOs, LDCs vs. 3rd parties

Regulatory Gaps

- End-of-life for battery technologies
  - Expected EV battery life – 7-10 years
  - Large EV fleets emerging (2 million EV sales in 2019; 5-6 million cumulative to date)
  - Potential economic value:
    - Common and rare earth metals (steel, palladium, vanadium, titanium)
  - Batteries contain CEPA “toxic” materials (nickel, cobalt), also manganese, lithium, complex chemistry

Figure 3: Cumulative global passenger EV sales, current and forecast



Source: Bloomberg NEF

Regulatory Gaps

- 2nd life in grid/building applications possible, but units will reach end-of -life.

- Post-consumer management essentially an unregulated activity
  - Existing practices
    - Export to unknown fate
    - Pyrometallurgy
    - Hydrometallurgy
    - Mechanical disassembly (preferred option)

    Hazardous waste streams

  - Battery design moving away from design for disassembly

End-of-life EV Batteries

- Existing battery EPR regimes pre-date emergence and large scale adoption of EVs
- EU and UK moving to apply battery directive/clarify rules
- Canadian/US regimes non-existent

US/Canada Regimes

- Answer about status as hazardous wastes, dangerous goods, EPR?
  - "We don't know."
  - "We're thinking about it."
  - A "wild west"

- Landfill bans in NY, Mn, California
- EPR Legislation proposed in California

End of Life EV Batteries

- Fate in Canada essentially in realm of private law between seller/lessor and buyer/lessee
- Potential service providers emerging (Ontario, Quebec) but market uncertain without clear regulatory regime
- Complications around EPR and second use

Conclusions

- Role of public goods regulation as barrier to innovation and adoption of new technologies potentially overstated
  - Efforts at "streamlining/agile/flexible regulation" can carry significant risks (e.g. Boeing Max)
- Key barriers to adoption/commercialization lie in the realm of economic regulation
- Inadequate attention given to downstream consequences of socio-technical transitions resulting in significant regulatory gaps
  - Risk to public safety and barrier to emergence of new services/technologies