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Efficient Rules for Planning and Regulating a Smart Grid

Presentation to the NERA/EPRG Winter Conference

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Insight in Economics™

Overview

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- Defining a smart grid, and why it is important to support / encourage their use in regulating distribution networks
- A traditional model of regulation, and why it does not encourage the use of “smart” measures.
- Mechanisms to address these problems with the “traditional model”, including:
  - Measures introduced through the UK RIIO model; and
  - Where further improvements are possible
- Conclusions

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What are "smart grid" measures, and when is it efficient to use them?

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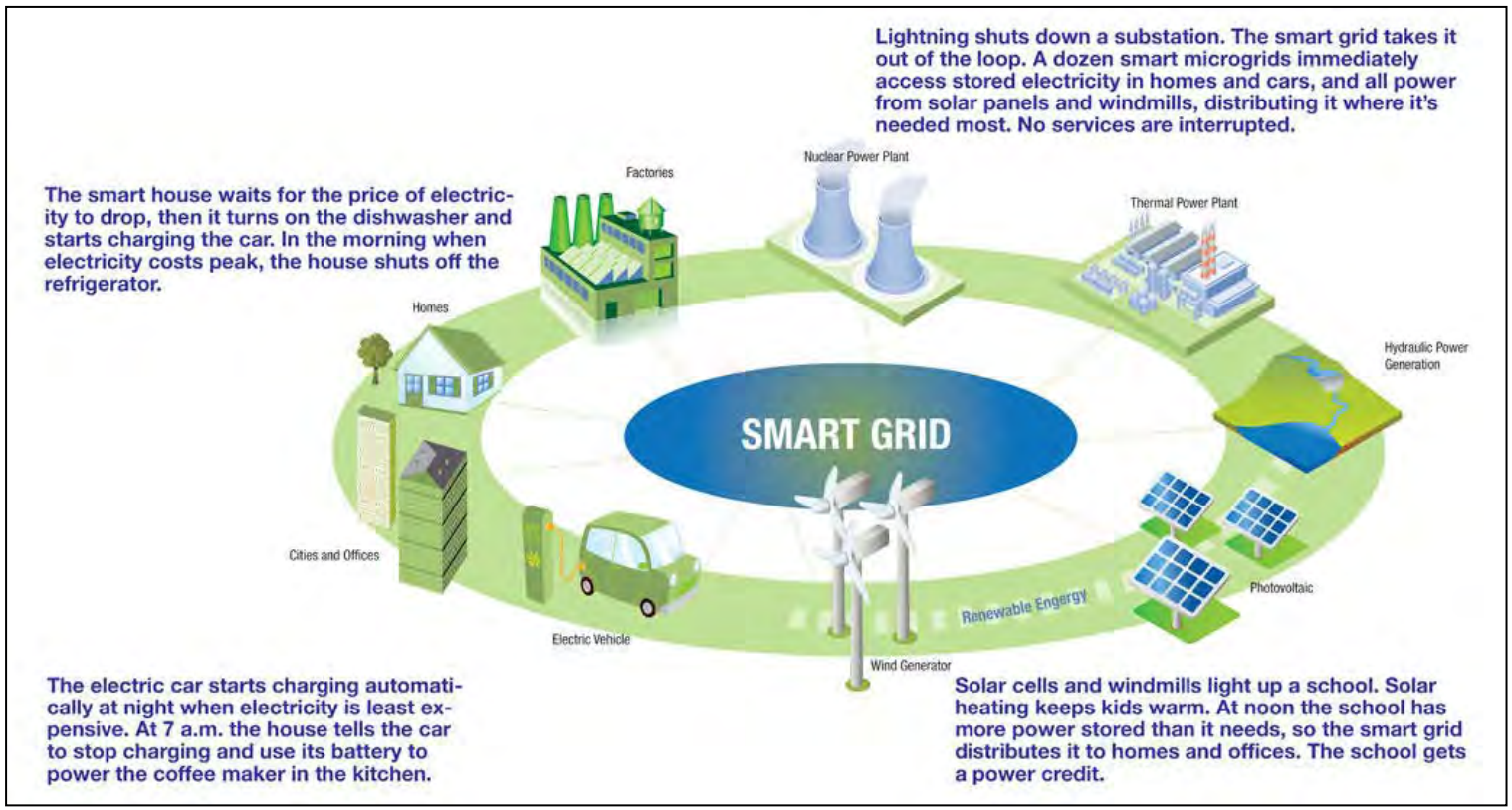
"A smart grid is an electricity distribution network that can monitor electricity flowing within itself and, based on this self awareness, adjust to changing conditions. It does this by automatically reconfiguring the network and/or exerting a level of control over connected demand and generation."

Source: Smart Grids for Dummies, Wiley (2010).



Source: University of Michigan website

From a distribution network operator's perspective, what is needed to deliver smart measures efficiently?

The package of incentives conveyed to the company through the process for setting price/revenue controls is a key driver of whether these necessary conditions for smart grids are provided

Important, but not the focus of this presentation

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Features of a "typical" framework for setting ex ante price controls using a building blocks approach

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$Revenue_t$ = Forecast Operating $Costs_t$

+ Depreciation of RAB_t

+ Estimated WACC x RAB_t

(+/-Net Revenue from Quality of Service Incentives)

Regulatory Asset Base $(RAB)_t = RAB_{t-1}$ + (Forecast) $Capex_t$ – $Depreciation_t$

- Revenues are fixed for several years at a time based on forecast costs
- Companies bear operating / capital cost overruns between reviews
- Reset of RAB at next periodic review in accordance with actual capex
- Opex / capex forecasts set through a mix of benchmarking / judgment

Will this framework deliver an efficient use of smart grid measures?

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Some aspects of this "traditional model" are supportive of smart measures

- ✓ Incentives to minimise operating costs during control periods
- ✓ Incentives to minimise capital costs during control periods
- ✓ Quality of service can be used to focus companies' attention on consumer outcomes, leaving them to identify the cheapest means of delivery

But there are some gaps that may prevent the efficient uptake of smart measures

- X But, capex biases in some models deter low capex/high opex smart schemes
  - Asymmetric treatment of opex and capex in cost forecasting
  - Possible WACC outperformance
  - Remuneration for historic investments tied to future use/usefulness of assets
- X Short periodic reviews cycles in some jurisdictions
- X Weak incentives for innovation or undertaking relatively "risky" anticipatory investments

European regulatory models do not tend to encourage smart grid deployment

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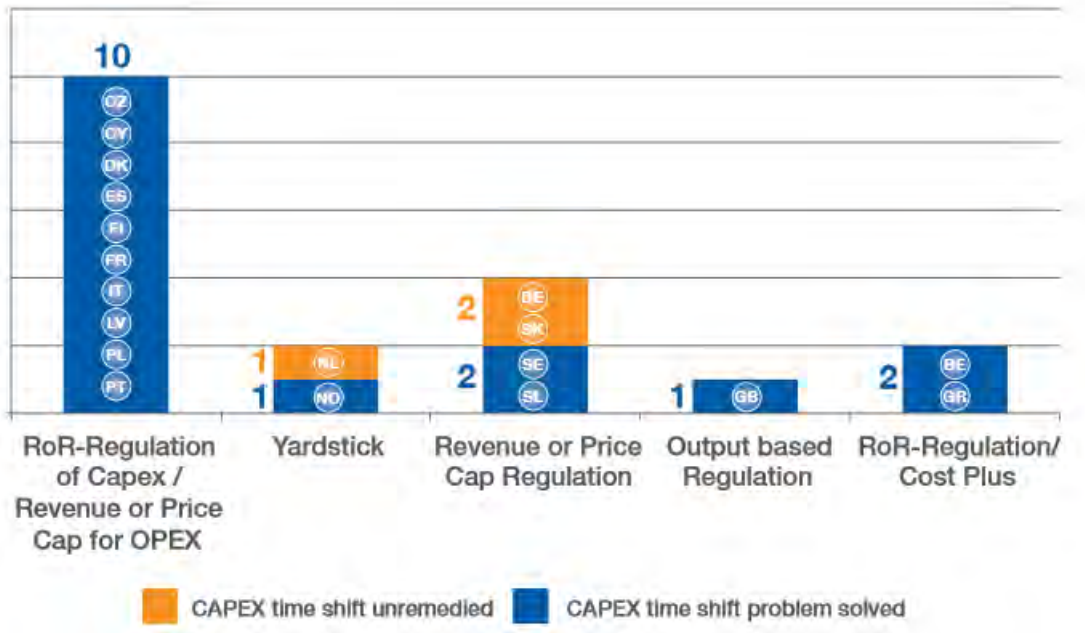
- Many EU jurisdictions still adopt regulatory methods that suffer from these shortcomings
- Most DSO's surveyed by Eurelectric say their regulatory frameworks do not support smart grid investments

Characterisation of regulatory regimes across the EU



Does the regulatory regime support innovation?

Source: Electricity Distribution Investments: What Regulatory Framework Do We Need?, Eurelectric, 2014.

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- What is a smart grid
- A traditional model of regulation and its deficiencies
- **Improvements introduced through RIIO and further enhancements**
- Conclusions

In GB, RIIO was designed to address some of these limitations of the conventional model

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Revenue =

- Symmetric treatment of opex and capex savings/overruns
- A common capitalisation rate for opex and capex
- Revenues set (in part) using "totex" cost assessment techniques

+ Incentives

- Longer (8-year) price controls to improve efficiency/incentives

+ Innovation

- Significant funding for innovation measures

+ Outputs

- Quality incentives that reward improvement in outcomes
- Obligations to deliver certain levels of investments

More focus on outcomes and clearer incentives to make efficient choices, plus innovation funding, should better encourage "smart" measures

Some aspects of Ofgem's cost assessment may discourage "smart" measures

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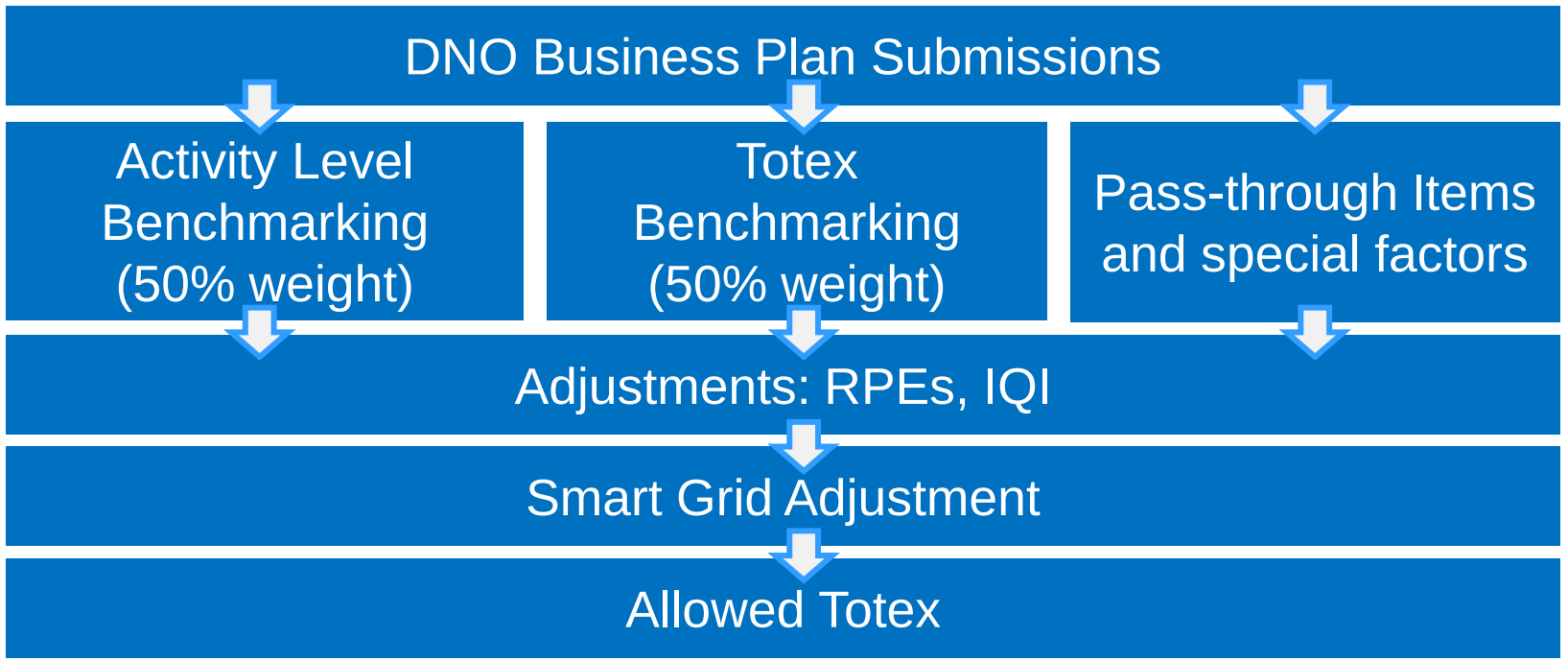
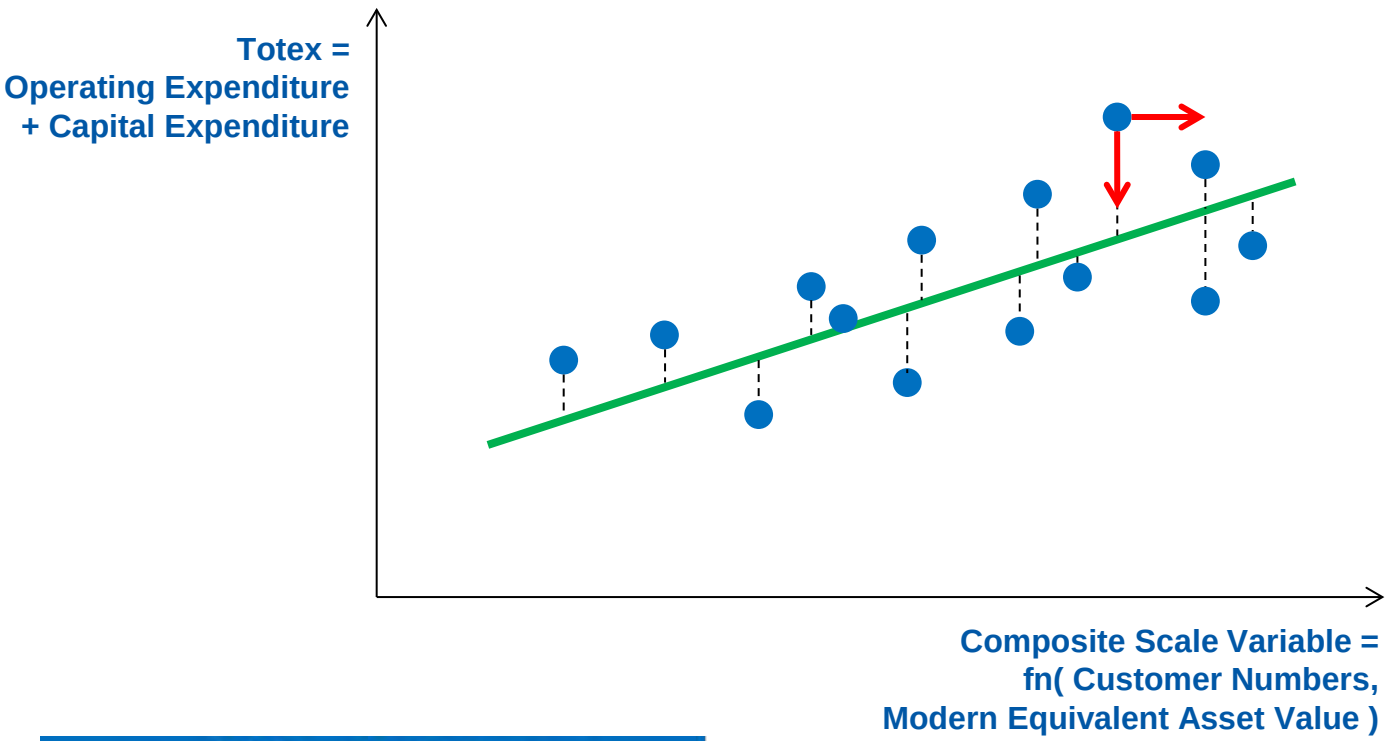
A range of techniques combined to form Ofgem's view of the "efficient frontier"



In particular, the totex benchmarking rewards adding assets and may deter "smart" investments



- Less expenditure (not cost) improves companies' position, which may deter companies from planning anticipatory/enabling investments
- Cost drivers depend on number of assets, so no compensation for higher IT costs, communication technology costs, etc

Ofgem's "Smart Grid Adjustment" involved setting specific, and more demanding, targets for smart savings

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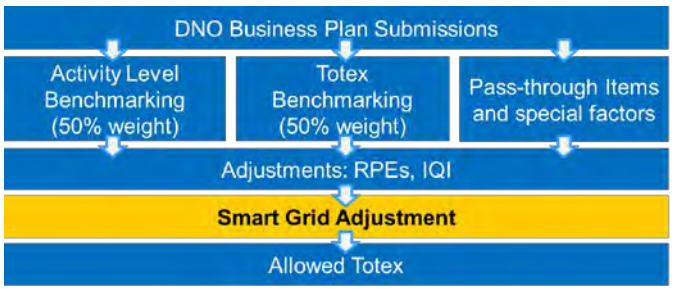
Ofgem set specific targets for smart grid savings when forecasting companies' costs

- Ofgem asked companies to forecast smart grid savings (relative to their baseline cost forecasts)
- It then asserted the savings put forward by DNOs were insufficient, and set specific, more demanding targets for smart grid savings through benchmarking



But problems with Ofgem's approach, illustrate the challenges smart grids create for regulatory regimes that rely on cost forecasts

- NPG's successful appeal to the CMA on this topic illustrates key problems with Ofgem's approach:
  - Ofgem's approach entailed significant subjectivity:
    - What is a smart measure?
    - How much money will they save?
    - Against what counterfactual?
    - Can all companies achieve the same savings?
  - Distorted incentives from special treatment of smart measures
  - Little evidence to support a more demanding target than in DNOs' business plans
  - Procedural flaws from changing approach during the review (incentive problems too?)

Overall, Ofgem's approach was probably detrimental to incentives to deliver smart grid measures efficiently

RIIO sets output obligations for reliability and availability, but they focus closely on intermediate outputs, and may deter smarter alternatives

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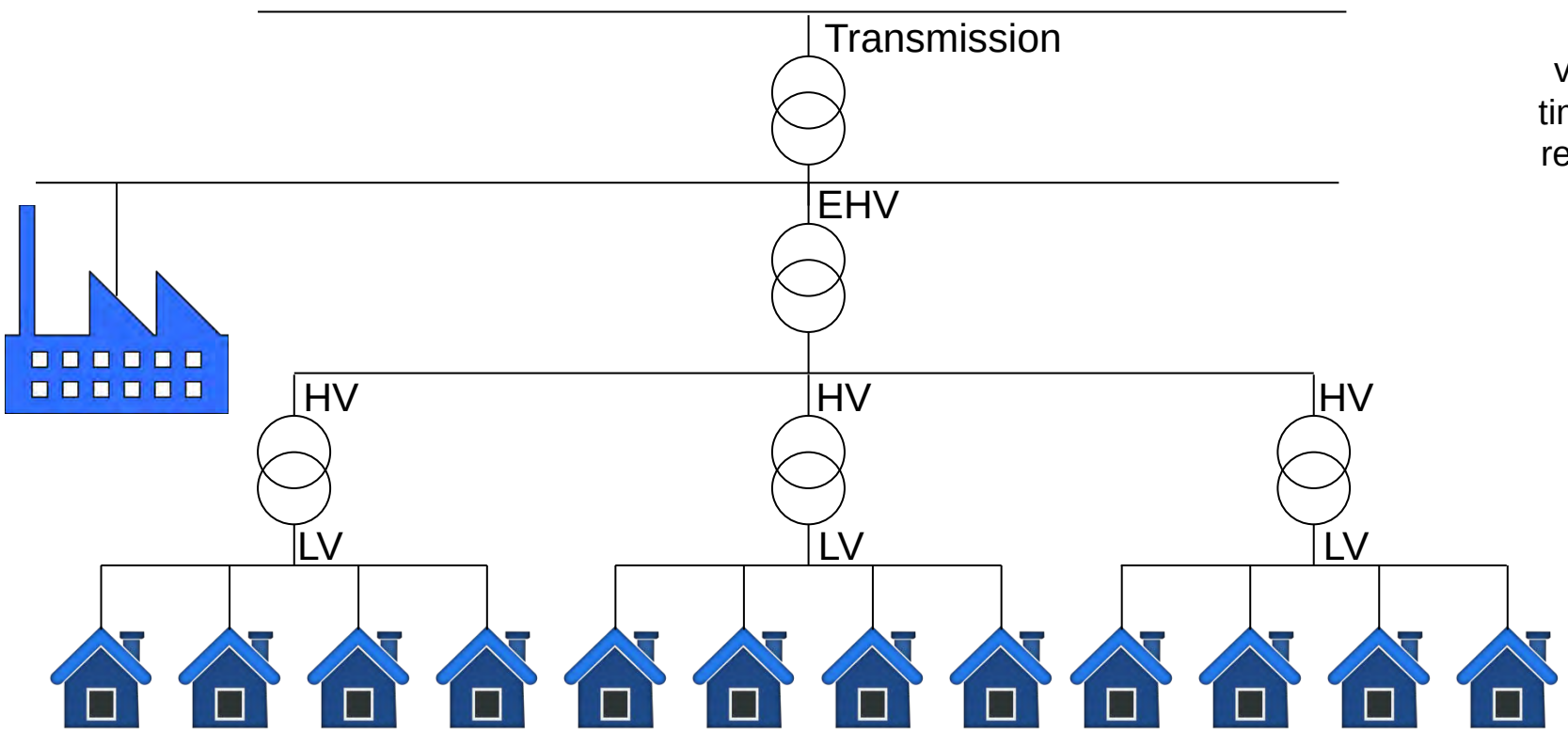
- RIIO seeks to focus on consumer outcomes, but includes some "secondary deliverables contracts", which link revenue to intermediate outputs
- They are used to measure long-term asset stewardship, etc, but may create capex biases and deter smart technologies

Secondary Deliverables	Key Features of Mechanism	Implications for Smart Incentives
Load Index	Links future revenue to delivering reductions in substation loading	• Increasing substation loading may be a symptom of effective use of smart technologies. • Hence, rewarding reductions in loading may deter the use of smart measures.
Health, Criticality and Risk Indices	Links future revenue to improving asset condition	• It may be cheaper to use non-network solutions to mitigate asset failures, rather than investing to improve asset health. • By encouraging replacement or refurbishment investments instead, this mechanism creates a possible capex bias..

Some regulatory frameworks still contain design standards that require/favor asset-heavy solutions. For instance:

- When an asset fails, P2/6 (a “planning standard”) tells DNOs how quickly supplies to affected consumers need to be restored
- Meeting these “minimum restoration times” typically requires redundancy, ie. duplication of assets



For assets serving larger peak demand at higher voltage levels, restoration times are short, which often requires redundancy of N-1 or N-2

At very low voltage levels, the minimum restoration time is just the time it takes to repair a fault. Hence, no redundancy required.

There is a trade-off between the simplicity of deterministic planning standards and their inflexibility

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Deterministic Planning Rules

- Simple to apply, which keeps planning costs low
- Transparent for network users to understand
- May stifle innovation

More Flexible Requirements, eg. Obligations to Plan Using CBAs

- No “one size fits all” approach to planning
- Can be used to optimise use of conventional / smart solutions
- Some jurisdictions, eg. Australia, are using these more flexible, less deterministic approaches

No standards; Rely on Incentives

- Most simple and potentially efficient approach
- But relying on financial incentives to encourage efficient choices may require reform of other regulatory mechanisms
- More risk exposure for distributors might affect financing costs

Some “smart” measures would require an active demand side; in many jurisdictions this would require new commercial arrangements

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- This presentation focuses on reform of traditional regulatory models for setting distributors’ revenues/incentives to support smart technologies
- Other challenges for regulation not widely discussed in this presentation:
  - More efficient distribution tariff designs, in particular with stronger peak signals
  - The ability for distributors to contract with consumers to provide network services
  - Connection charges / terms for embedded storage, generators, etc.
  - Regulation around smart meters
    - Ensuring a clear mandate and a channel for cost recovery
    - Data exchange, compatibility arrangements, etc

Sound regulation of distribution losses is also be required to ensure overall efficiency, and this might erode the role for smart technologies

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- Smart methods typically strive to economise on the costs of providing network capacity, in effect increasing the utilisation of assets
- But high energy prices means it may increasingly be economic to oversize distribution assets to reduce losses
  - When replacing assets it is probably efficient to install much "fatter" wires/cables
  - Fatter cables implies significant surplus capacity, and no less role for smart!

Least-cost maximum loading (%) for various electricity costs, discount rates and asset lives

Assets		High electricity cost			Low electricity cost		
		Discount rate					
		3.5%, 45 years	4%, 20 years	9%, 20 years	3.5%, 45 years	4%, 20 years	9%, 20 years
Cables	LV	12 - 25	16 – 32	20 – 39	18 - 35	23 – 45	28 – 55
	HV	14 - 27	18 – 35	21 – 43	19 - 39	25 – 50	30 – 60
	EHV	17 - 33	22 – 43	27 – 52	24 - 47	31 – 61	37 – 74
OH lines	LV	11 - 19	14 – 24	18 – 30	15 - 27	20 – 35	25 – 43
	HV	8 - 14	11 – 18	13 – 22	12 - 20	15 – 26	18 – 32
	EHV	10 - 18	13 – 22	16 – 28	14 - 25	18 – 32	22 – 39

Source: Management of electricity distribution network losses, IFI Project for WPD by Imperial College London and Sohn Associates, February 2014

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Conclusions

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- Traditional regulatory models need to adapt if regulators aspire to encourage the efficient use of smart distribution network technologies
- Ofgem's RIIO model is leading the way in Europe, but some improvements are possible:
  - Closer focus on consumer outcomes in setting revenues and incentives to avoid deterring smart investments and operating measures
  - Reform of planning standards and obligations
  - Regulation to mitigate losses is also important for ensuring smart measures are not used when adding capacity would be more efficient
- Aside from the regulation of revenues, outputs and incentives for distributors, a range of other aspects of regulation are also important:
  - Notably, smart meters and smart charging structures

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