UNIVERSITY OF CAMBRIDGE | Electricity Policy Research Group

How to promote renewables effectively & efficiently

Implementing EU Renewables Directive

IAEE Annual Conference
Vienna 10-13 Conference September, 2009

Karsten Neuhoff

With input from Adam Rysanek, Sarah Lester, Simone Cooper

SUPERGEN

E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL

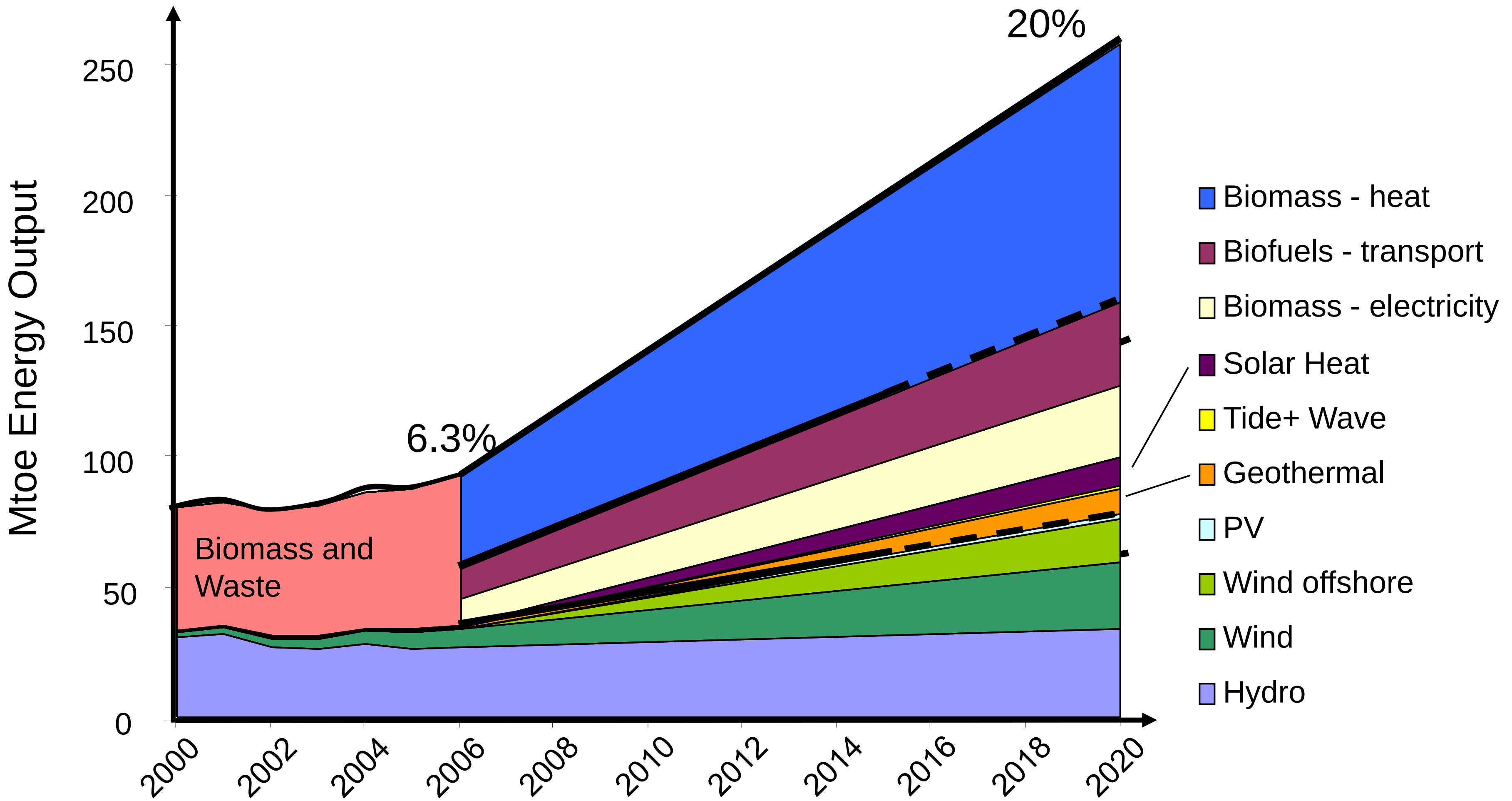
EU and national policy to achieve EU renewable targets

- **Offer guidance** to coordinate investment
- **Deploy flexible market design** to avoid delays
- **Demonstrate commitment** to attract investment
- **Monitor** to create accountability&responsiveness
- **Carry regulatory risk** to attract capital at low cost

SUPERGEN

E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL

Allocating across time & fuels



SUPERGEN

Based on Green-X projections

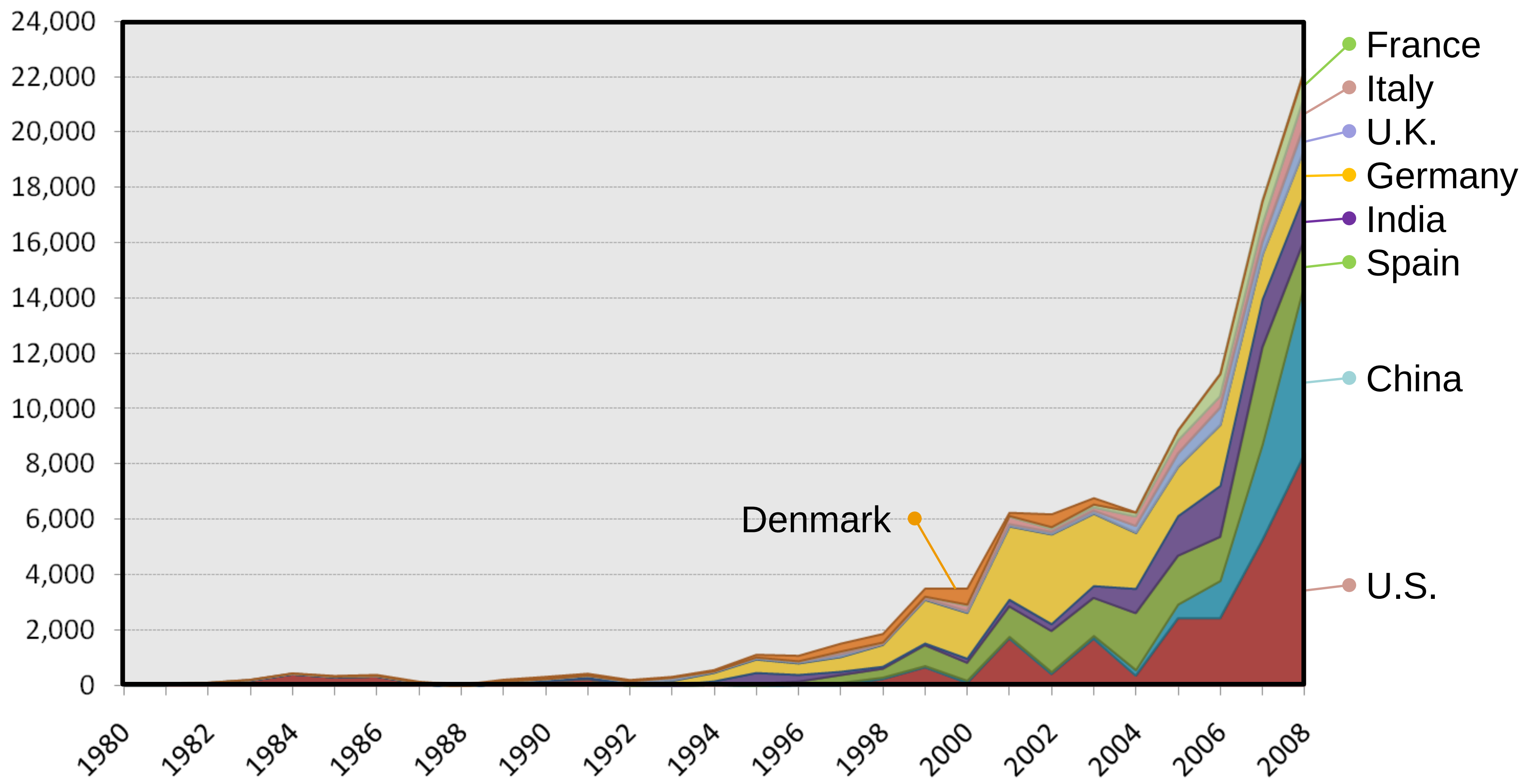
Policy targets frame public & private investment

Guidance from
- Consistent objectives
- Strategic choices

Electricity Policy Research Group

Creating confidence for investors in supply chain

Installed wind power per year (MW)



Source: IEA, GWEC, Worldwatch Institute

SUPERGEN

UNIVERSITY OF CAMBRIDGE | Electricity Policy Research Group

Governments role in managing a transition to large scale use of renewables

- **Offer guidance** to coordinate investment
- **Deploy flexible market design** to avoid delays
- **Demonstrate commitment** to attract investment
- **Monitor** to create accountability&responsiveness
- **Carry regulatory risk** to attract capital at low cost

SUPERGEN

E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL

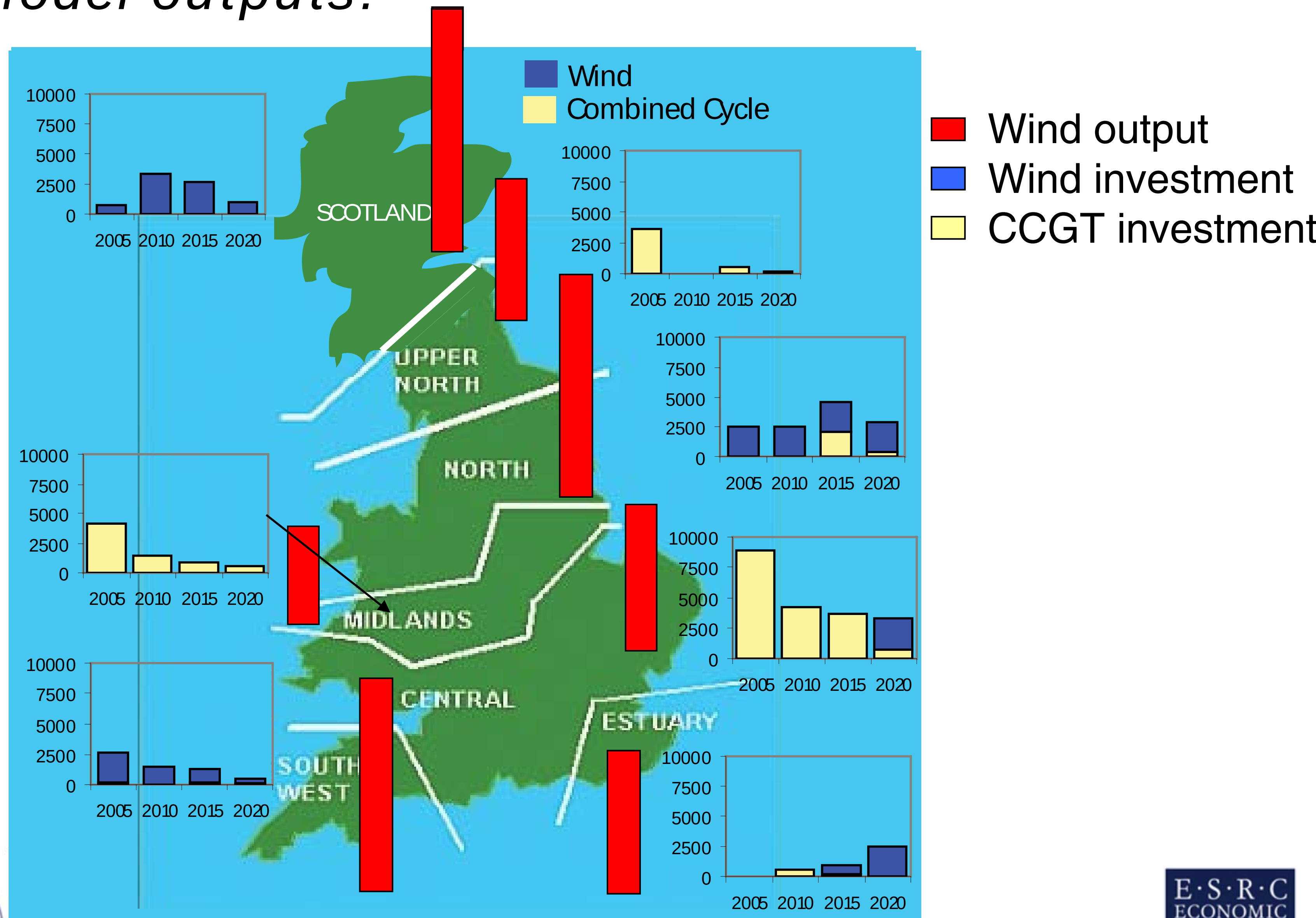
Current transmission access

- Connect for firm access
  - delay until reinforcements in place
  - > excessive T capacity for wind
  - > excessive delays in connecting wind
- TSO uses contracts and balancing mechanism to manage congestion
  - weak incentives on G to manage output
  - costly to deal with congestion

SUPERGEN

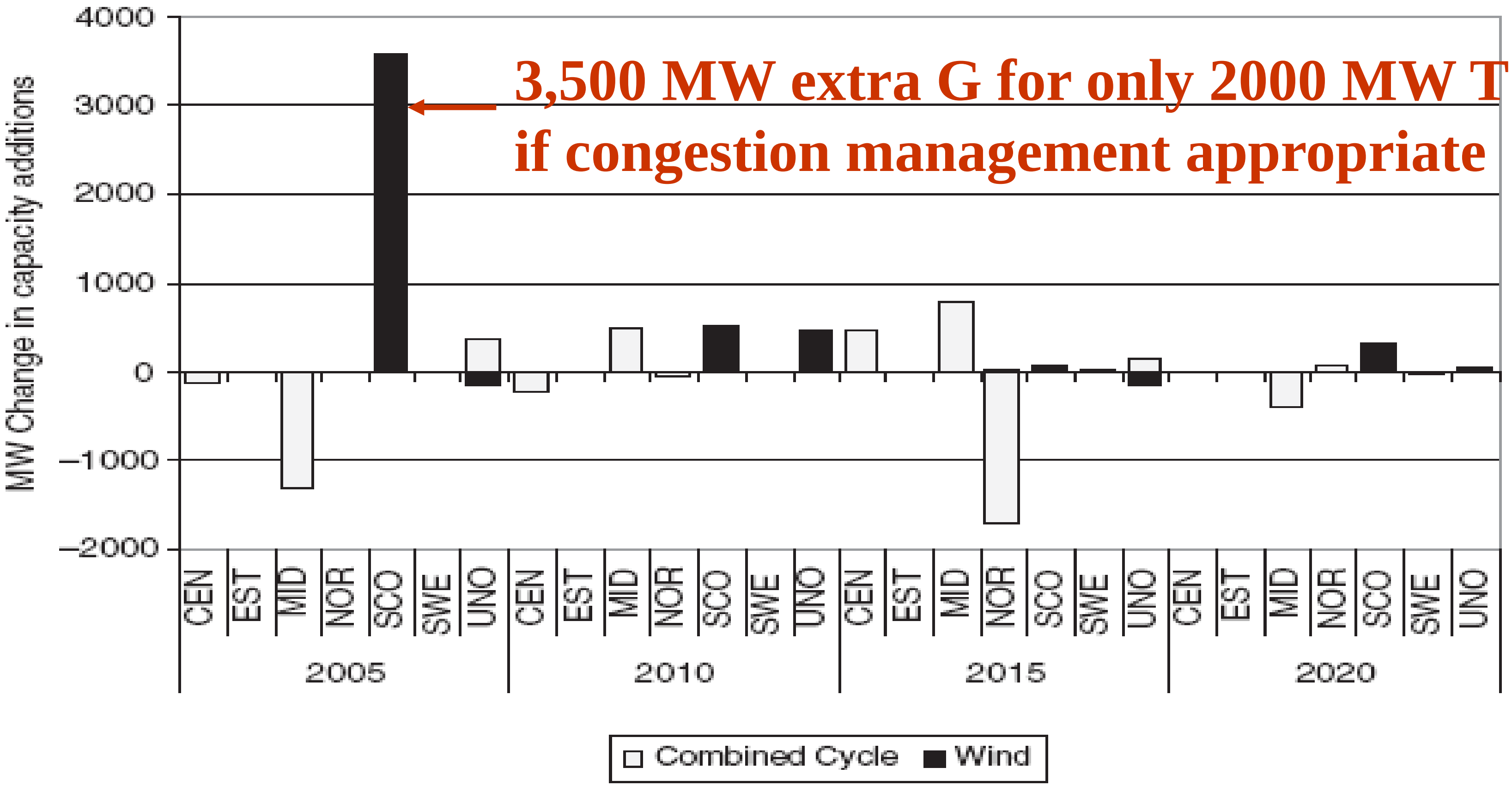
E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL

Our model outputs:

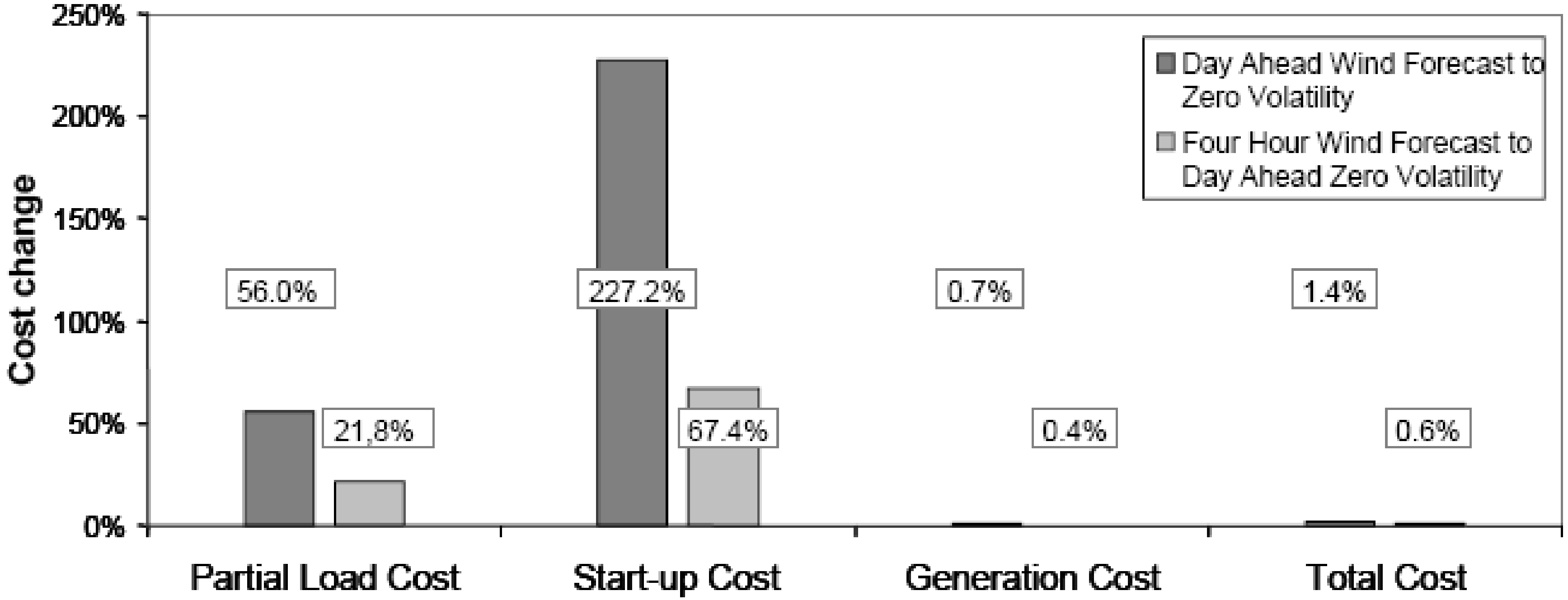


Source: Neuhoff et al. Space and Time: Wind in an Investment Planning Model, Energy Economics.

Nodal pricing for effective network utilisation



The value of optimised dispatch

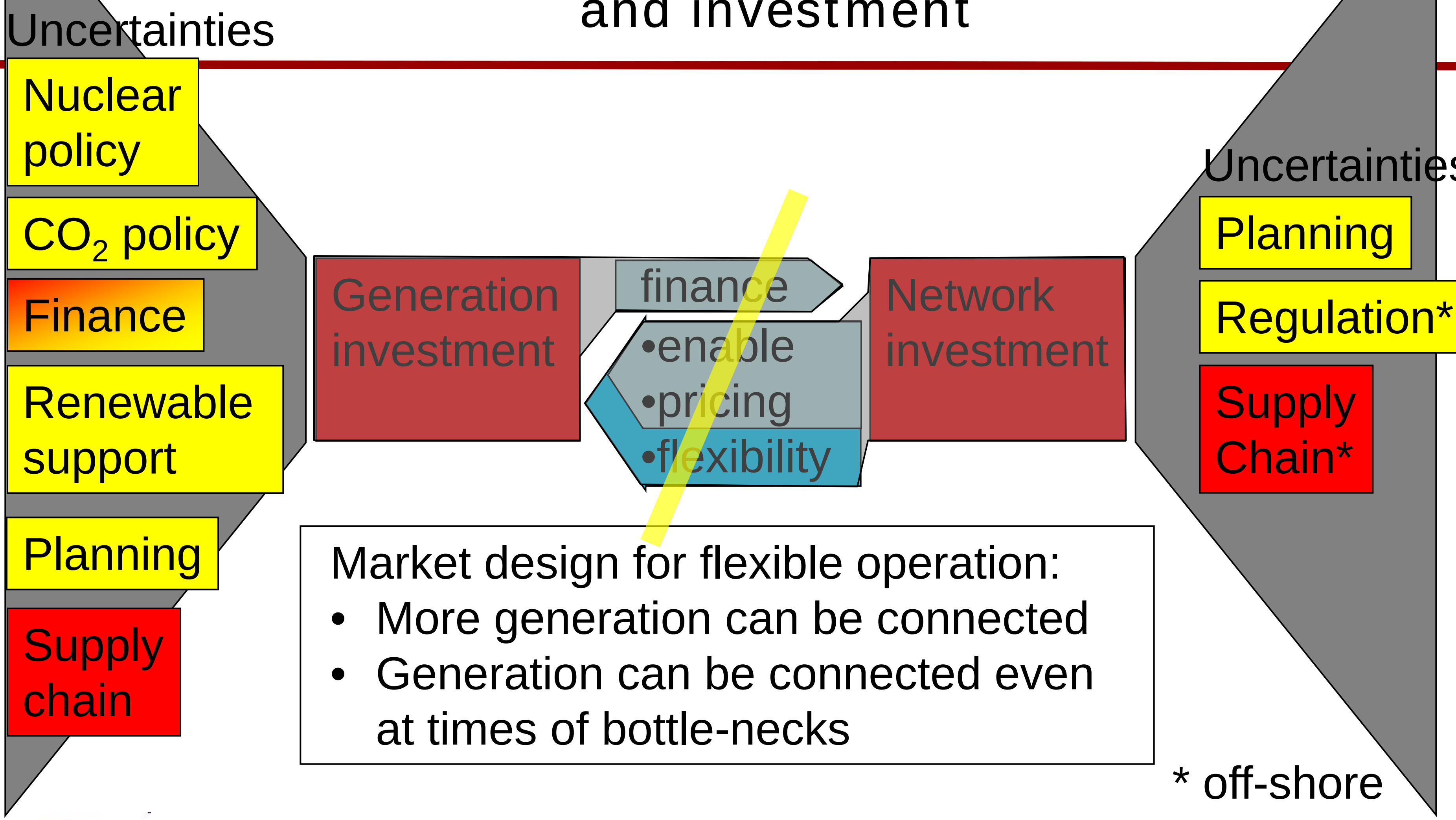


Müsgens, F. and Neuhoff, K., 2006, Modelling Dynamic Constraints in Electricity Markets and the Costs of Uncertain Wind Output, EPRG Working Paper 05/14

Spatial and temporal optimisation

- **Nodal price** reflects congestion & marginal losses
  - lower prices in export-constrained region
  - efficient investment location, guides grid expansion
- **Central dispatch** for efficient scheduling, balancing
- **Market power monitoring** – benchmark possible
- PJM demonstrates that it can work
  - Repeated in NY, New England, California

Market design to support operation and investment



Market design for flexible operation:

- More generation can be connected
- Generation can be connected even at times of bottle-necks

* off-shore

SUPERGEN

E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL

Governments role in managing a transition to large scale use of renewables

- **Offer guidance** to coordinate investment
- **Deploy flexible market design** to avoid delays
- **Demonstrate commitment** to attract investment
- **Monitor** to create accountability&responsiveness
- **Carry regulatory risk** to attract capital at low cost

SUPERGEN

E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL

Incentives for compliance with EU renewable targets

Several options:

- Legal enforcement, possible financial penalty
- Positive encouragement
  - TEN, Agricultural etc funding in exchange for delivery against objective
- Naming and shaming

Investing in the grid – to demonstrate commitment: The European "SuperGrid"

The "EUMENA" Concept

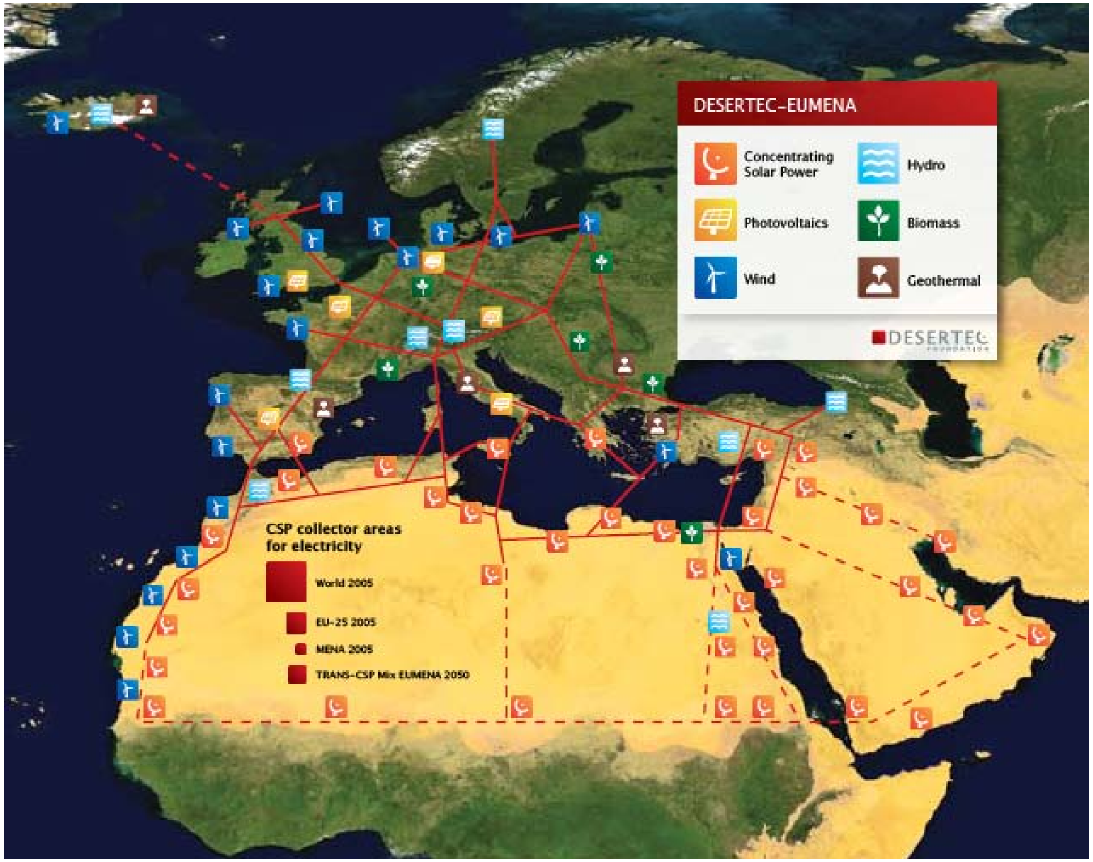
Mediterranean-focused HVDC Transmission "Highways" to complement the existing AC infrastructure

Objective for Grid Expansion:

By 2050, expand Europe's transmission capacity to accommodate a 15% electricity supply contribution from concentrated solar power (CSP) resources in North Africa. This does not include the expected contribution of CSP to North Africa's generation mix, which will be significant.

Transmission Investment:

45€ Billion between 2020 and 2050



Reference:
DESERTEC. Clean power from deserts, The Club of Rome. Hamburg: Whitepaper; 2007.

SUPERGEN

E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL

Investing in the grid – to demonstrate commitment: The North Atlantic Offshore Wind Transmission Corridor

Objective for Grid Expansion:

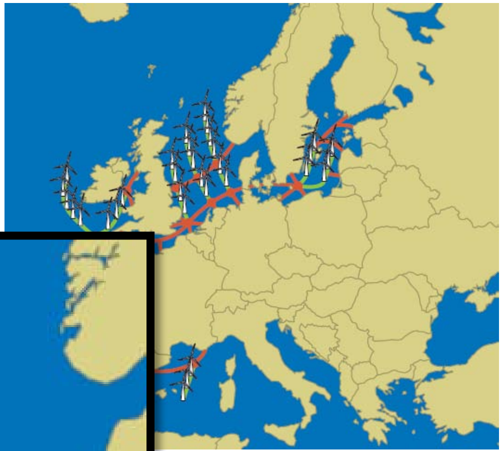
EU-DG TREN: Support the development of 129 to 187 TWh/a of offshore wind generation by 2020 (between 3.7% and 5.9% of total generation demand of EU-15)

Airtricity's 10GW Foundation Project: Provide 10 GW of offshore wind generation capacity (approx. 35 TWh/a) with grid connection to the UK, Netherlands, and Germany

Transmission Investment:

EU-DG TREN: Between 7.7€ billion and 11.8€ billion between 2005 and 2013; between 17.1€ billion and 25.4€ billion between 2014 and 2023

Airtricity: 2€ Billion between 2011 and 2015



Future SuperGrid

10 GW Foundation Project

References:

Airtricity,"European Offshore Supergrid Proposal", Airtricity, Dublin, 24 pp., May 2006.

DG TREN. TEN-Energy-Invest. Brussels, Rambøll A/S: European Commission, Directorate-General Transport and Energy (DG-TREN), CESI spa, Instituto de Investigacio´n Tecnolo´ gica, Mercados Energeticos; 2005.

Improvements to Transmission Technology and Practices

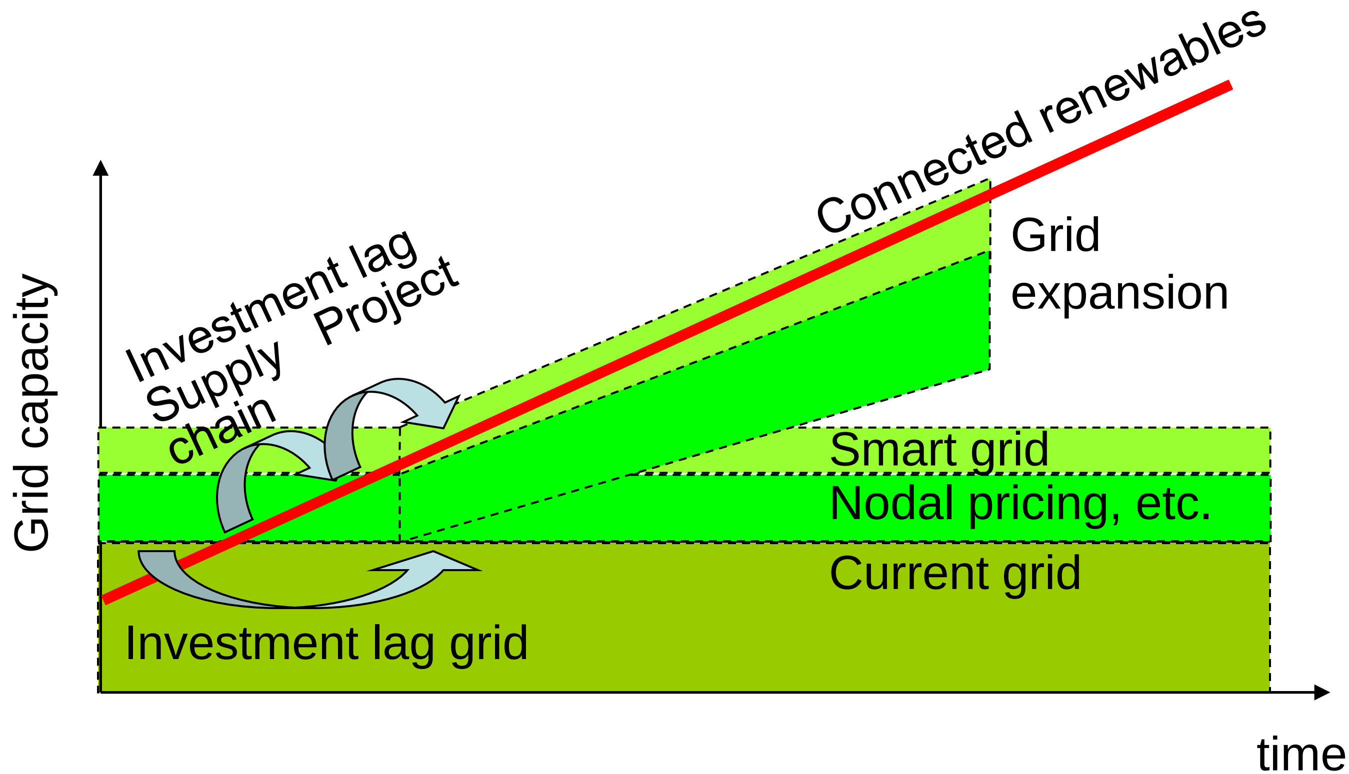
Flexible AC Transmission Systems (FACTS)

Technology: FACTS	Location (country or priority axis)	Characteristics	Costs(*)	Feasibility
Phase Shifter Transformers	EL1 (Netherlands) EL2 (France-Italy) EL3 (France-Spain); Poland	➢ Possibility of controlling power flows in cut-sets with parallel lines having different loading levels	16÷70 €/kVA	**High**
Static Var Compensator (SVC)	Ireland; Belgium(**), France; UK; Sweden,	➢ Voltage control and reactive power management ➢ Dynamic voltage stabilisation	35-90 €/kVar	**High**
Static Synchronous Compensator (STATCOM)	UK	➢ Voltage control and reactive power management ➢ Dynamic voltage stabilisation ➢ Improved power system damping ➢ Power quality improvement	60-130 €/kVar	**Medium**
Thyristor Control Series Capacitors (TCSC)	Sweden	➢ Power Flow control ➢ Improve transient and voltage stability ➢ Damping electromechanical oscillations ➢ Aid in mitigation of subsynchronous resonances	50-130 €/kVA	**Medium**
Synchronous Static Series Compensator (SSSC)	----	➢ Power flow control ➢ Other basic functions as in TCSC technology	--------	**Medium-Low**
Unified Power Flow Controllers (UPFC)	----	➢ Active-reactive power control and voltage control	90-170 €/kVA	**Low** only prototype applications in USA

(*) Costs are highly dependent on the size of the FACTS device and the operating voltage, then the costs relevant to the most common size range are displayed.
(**) SVC installed only in conjunction with arc furnaces

Table from: *DG TREN. TEN-Energy-Invest. Brussels, Rambøll A/S: European Commission, Directorate-General Transport and Energy (DG-TREN), CESI spa, Instituto de Investigacio´n Tecnolo´ gica, Mercados Energeticos; 2005.*

Matching transmission and generation



- Provide visibility for supply chain and project investors
- Coordinate grid expansion with generation investment

Governments role in managing a transition to large scale use of renewables

- **Offer guidance** to coordinate investment
- **Deploy flexible market design** to avoid delays
- **Demonstrate commitment** to attract investment
- **Monitor** to create accountability&responsiveness
- **Carry regulatory risk** to attract capital at low cost

SUPERGEN

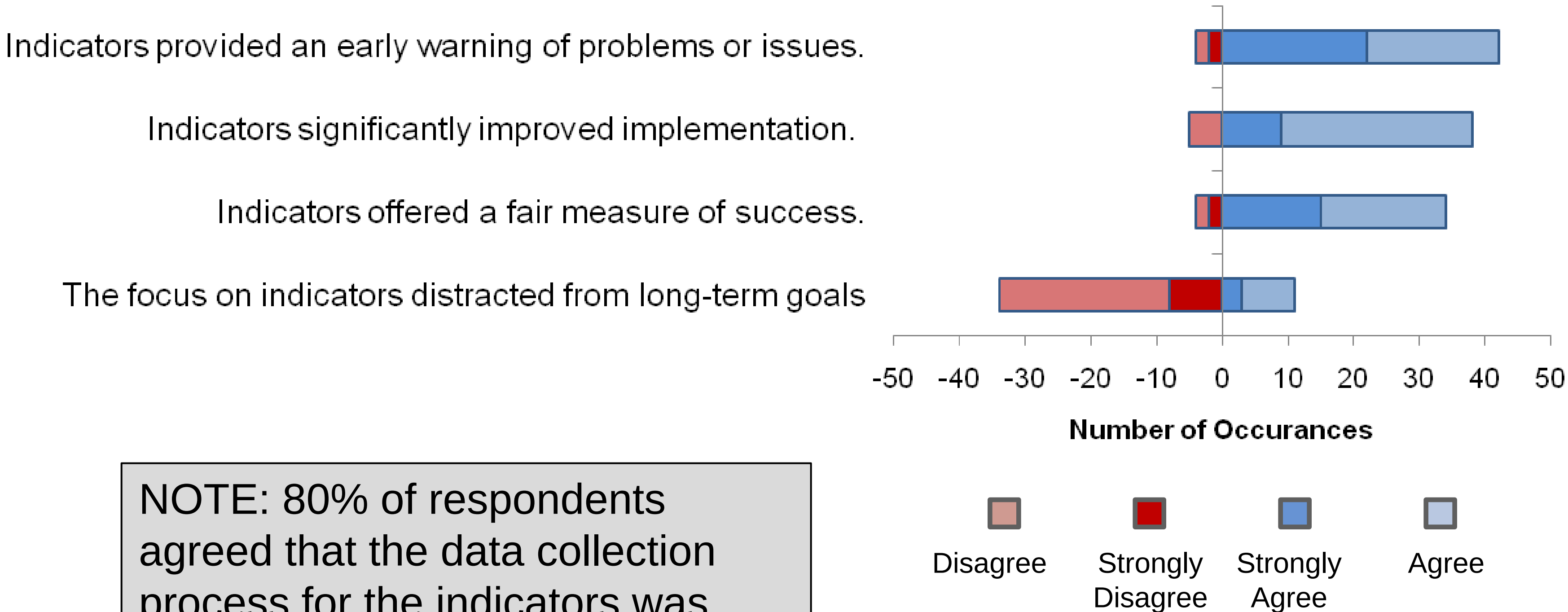
E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL

Monitoring Progress using Indicators

- Widely used across many levels/sectors of economy
- Allow for performance benchmarking
- Increase domestic accountability
- Facilitate evidence based (international) dialogue

Examples of Indicators used Across Sectors: EPRG Survey

Ability of indicators to facilitate policy / project management



NOTE: 80% of respondents agreed that the data collection process for the indicators was labour intensive

Measuring policy actions towards the EU Renewables Directive: NREAPs

- By June 2010, each EU Member State must submit a National Renewable Energy Action Plan (NREAP) which describes how the EU Renewables Directive target will be achieved domestically

- The NREAPs require member states to provide specific RE supply targets, and detail specific actions taken to:

1) **Provide appropriate planning regimes for deployment of RE projects**
2) **Provide grid / market infrastructure and access to new RE generators**
3) **Provide financing (directly or through incentives) for RE projects**

Inform the known barriers to RE deployment

Barriers along the RE pipeline

Global Input: Technically-Feasible RE Generation Capacity → **Planning** → **Access to Grid and Energy Market** → **Supply Chain** → **Project Finance** → **Global Output:** Installed / Target RE Capacity

Planning – Barriers

- Lack of effective legal / regulatory framework
- Lack of private participation and professional institutions
- Uncertainty with government policies
- Lack of coordination between authorities
- Lack of consumer/social acceptance of RE technologies

Access to Grid and Energy Market – Barriers

- Highly controlled energy sector
- Lack of grid access for RE technologies
- Lack of clear practises and procedures (related to planning barriers)
- Lack of available grid capacity
- High grid connection costs for RE developers (poor cost allocation)
- Lack of access to energy market

Supply Chain – Barriers

- Lack of competition and lack of standards and codes of certification
- Lack of entrepreneurs, skilled labour, and training and O&M facilities
- Lack of R&D capacity
- Restricted access to technologies
- Lack of reliability of products
- Lack of institutions / mechanisms to disseminate information

Project Finance – Barriers

- Financial Support (costs, risks, ...)
- Energy Market (access, structure, long-term costs, ...)
- Capital Market (perception of technical risk, perception of regulatory risk, ...)
- Visibility (uncertainty, ...)

SUPERGEN

E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL

Barriers along the RE pipeline:
Indicators provided in NREAPs:

Global Input: Technically-Feasible RE Generation Capacity

Planning → Access to Grid and Energy Market → Supply Chain → Project Finance

Global Output: Installed / Target RE Capacity

Planning – Barriers

- Lack of effective legal / regulatory framework
- Lack of private participation and professional institutions
- Uncertainty with government policies
- Lack of coordination between authorities
- Lack of consumer/social acceptance of RE technologies

Access to Grid and Energy Market – Barriers

- Highly controlled energy sector
- Lack of grid access for RE technologies
- Lack of clear practises and procedures (related to planning barriers)
- Lack of available grid capacity
- High grid connection costs for RE developers (poor cost allocation)
- Lack of access to energy market

Supply Chain – Barriers

- Lack of competition and lack of standards and codes of certification
- Lack of entrepreneurs, skilled labour, and training and O&M facilities
- Lack of R&D capacity
- Restricted access to technologies
- Lack of reliability of products
- Lack of institutions / mechanisms to disseminate information

Project Finance – Barriers

- Financial Support (costs, risks, ...)
- Energy Market (access, structure, long-term costs, ...)
- Capital Market (perception of technical risk, perception of regulatory risk, ...)
- Visibility (uncertainty, ...)

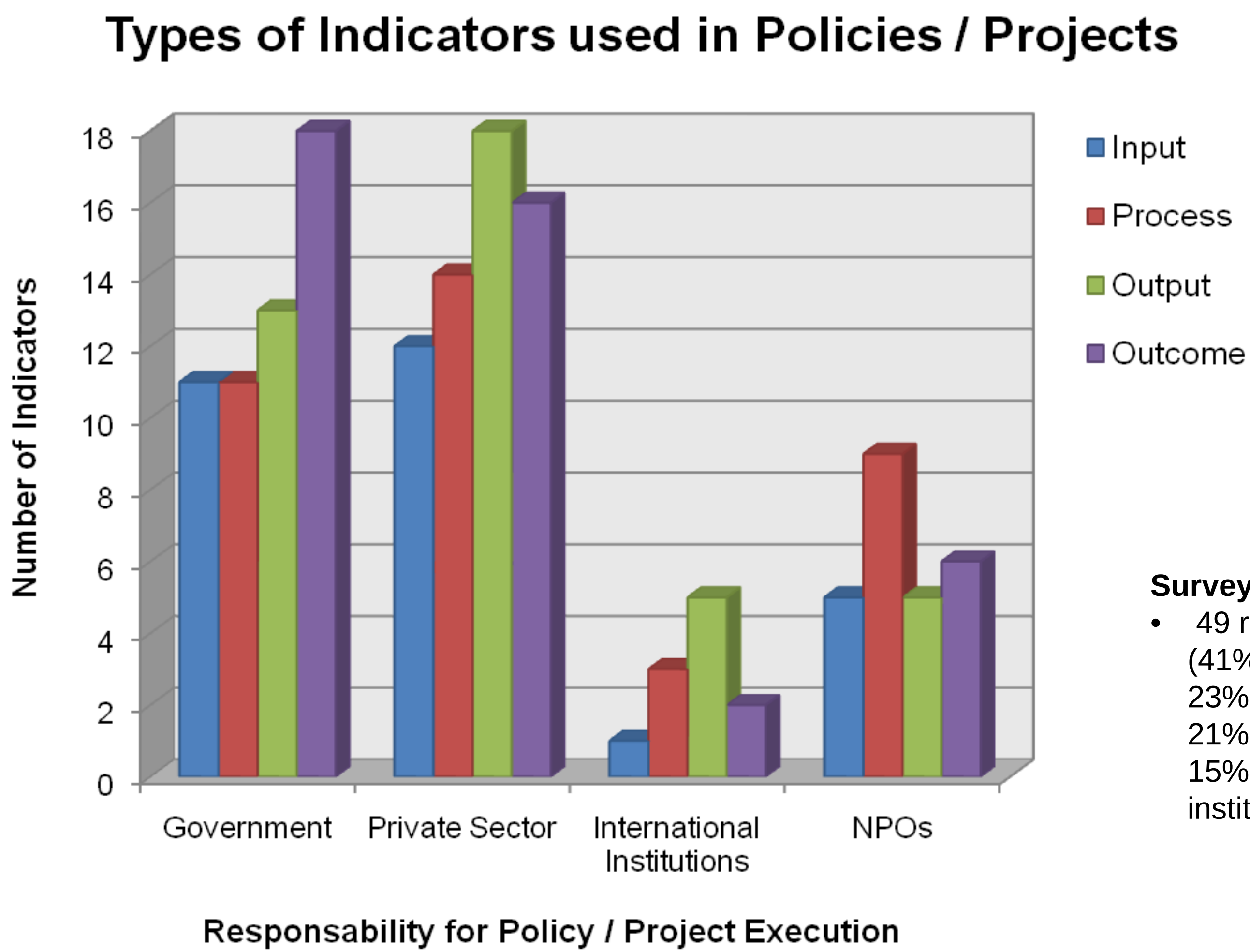
Qualitative indicators

Quantitative and qualitative indicators

Not covered

SUPERGEN

Examples of Indicators used Across Sectors: EPRG Survey



Survey Data:

- 49 respondents (41% private sector, 23% government, 21% NPOs, 15% international institutions)

SUPERGEN

E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL

Examples of Regularly-Reported Indicators along the RE Pipeline

Planning

Indicator	Source(s)
Number of RE Certificates (or FIT contracts) issued	Various nat. bodies (EU, Aus, Can)
Poll of public opinion of RE technologies	BERR (UK)

Access to Grid and Energy Market

Indicator	Source(s)

Supply Chain

Indicator	Source(s)
Public and private investments in RE technologies	IEA, UNEP, New Energy Finance
RE trade barriers (exports)	Foreign Affairs (Canada)
Import tarriffs on RE technologies	EC Tax. and Customs Union Datab.
Number of incubators in clean energy market	UNEP, New Energy Finance
Employment in the RE sector, per technology	BMU (Germany)
Number of p[ub]... traded comp[a]n... in the RE se[cto]...	
Total market share of three largest energy suppliers and generators	Swedish Energy Agency

Project Finance

Indicator	Source(s)
Comprehensive private investment statistics in RE sector (multiple indicators)	UNEP, New Energy Finance
Distribution of energy subsidies within EU-15, RE and non-RE	EEA
Type of public financial support scheme for RE-projects	IEA
Investment and production costs c...	IEA
Amount of public financial support provided	Various nati. bodies (EU, Aus, Can)

More Exist

- **Input Indicators** (resources / actions taken to address a problem)
- **Process Indicator** (initial reaction to input activities)
- **Output Indicators** (direct results of policies / actions taken)

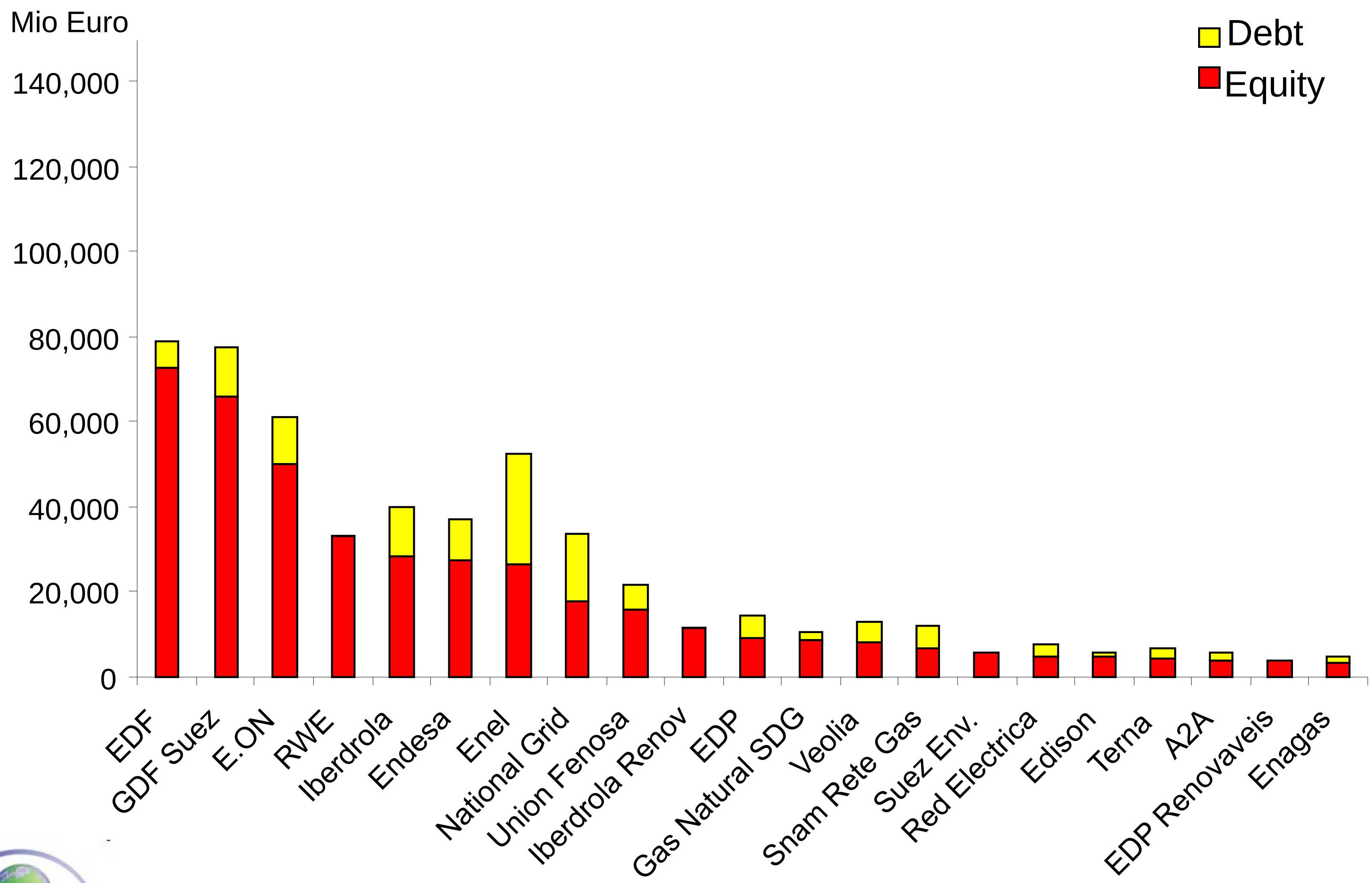
Governments role in managing a transition to large scale use of renewables

- **Offer guidance** to coordinate investment
- **Deploy flexible market design** to avoid delays
- **Demonstrate commitment** to attract investment
- **Monitor** to create accountability&responsiveness
- **Carry regulatory risk** to attract capital at low cost

SUPERGEN

E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL

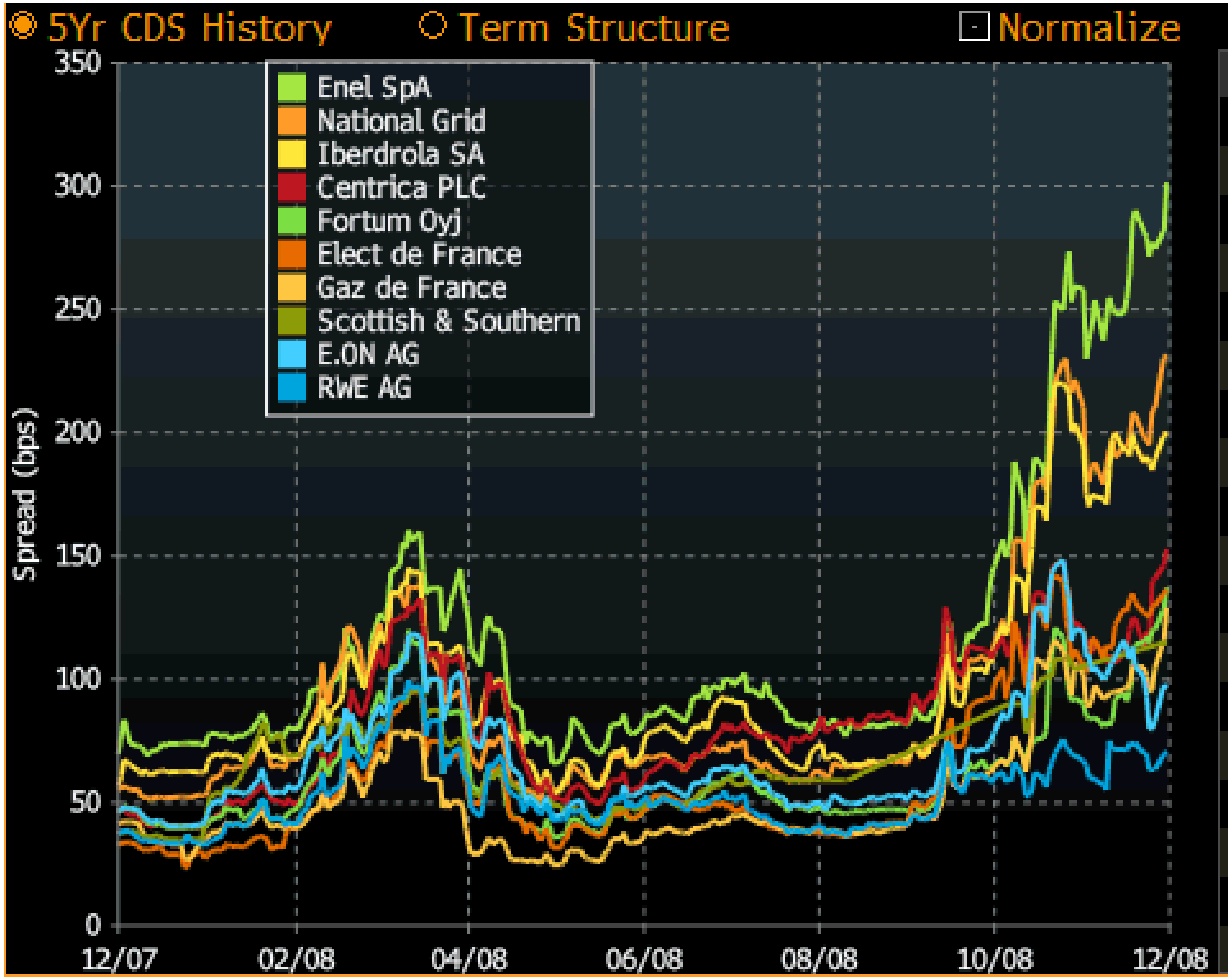
Current capital structure (fall 08)



SUPERGEN

UNIVERSITY OF CAMBRIDGE | Electricity Policy Research Group

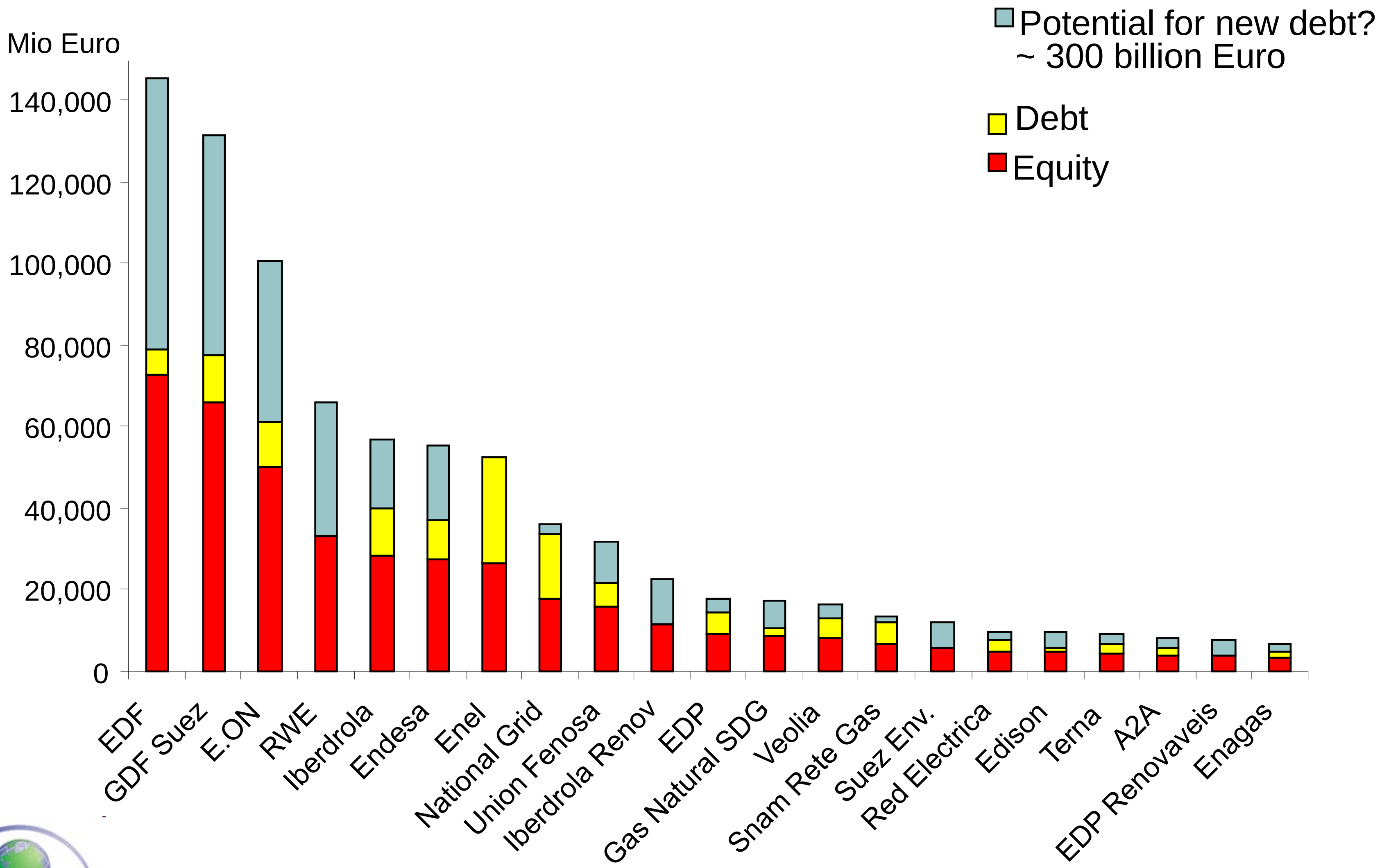
Cost of debt – reflecting perceived risk



SUPERGEN

UNIVERSITY OF CAMBRIDGE | Electricity Policy Research Group

How much debt could utilities raise?

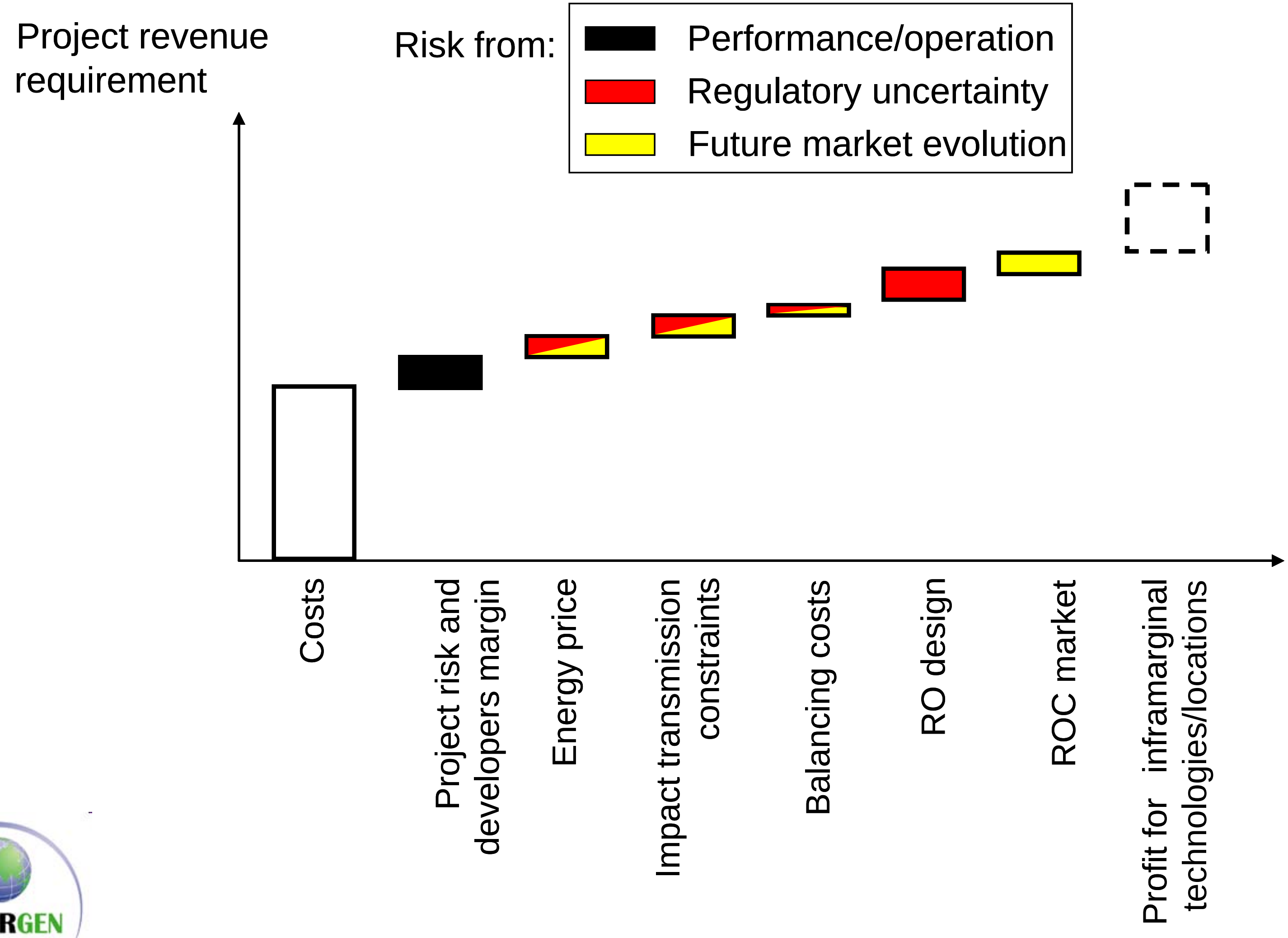


SUPERGEN

Missing so far Vattenfall, Centrica ..

UNIVERSITY OF CAMBRIDGE | Electricity Policy Research Group

Investors' risk – an important design criteria



Source: Take-or-pay contracts for Renewables Deployment, with Johnston and Kavali

SUPERGEN

E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL

Governments role in managing a transition to large scale use of renewables

- **Offer guidance** to coordinate investment
- **Deploy flexible market design** to avoid delays
- **Demonstrate commitment** to attract investment
- **Monitor** to create accountability&responsiveness
- **Carry regulatory risk** to attract capital at low cost

SUPERGEN

E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL