



Identifying the challenges related to increasing degrees of renewables penetration: the Paradigms Approach

Hugo Chandler, IEA

Grid Integration of Electricity from Renewable Energy

Technology Experts Meeting

May 29th 2007





What are the essential power system (technical) elements governing the integration of renewables?

What needs to be done to increase efficient uptake?

“Issue Fog”



Potential Showstoppers:
challenged identified but
not yet properly addressed

Challenges identified, but resolution subject to opposing views

Challenges identified, method of resolution agreed, further work required

Challenges to be addressed in the longer term

Myths – still lingering and to be discarded



The IEA report to the G8 (Japan 2008) aims to help policy makers see through the fog to the priorities

...How?



Electricity system paradigms

- Simple, qualitative models
 - Classes of shared national and regional system characteristics
 - Portraying real life, present day experiences with renewables
- Emphasising priority challenges and solutions related to renewables integration
- Principal characteristic: degree of variable RES penetration
- Further defined by system flexibility characteristics
 - interconnection, flexible (dispatchable) generation, storage, etc.
 - And by other “smoothing” characteristics: geographic distribution of VOTs, demand side response, etc.



Paradigms proposed

Scale of variable output technologies (VOTs) in generation portfolio

- First order RES-E production: including VOT share of up to 10%
- Second order RES-E production: including VOT share of up to 20%
- Third order RES-E production: including VOT share of 30% and above

Isolated systems

- High VOT (RES) production within isolated / nearly isolated systems (e.g. large islands)
- Hybrid RES production within small isolated systems (e.g. off-grid / micro-grid applications in developing countries)

Caveat

- Intention is not to artificially cluster or over simplify



Why use this approach?

- To ease identification by national policy makers of the issues relevant to their particular case
- One set of recommendations would be too vague to be useful
 - Tasks depend on specificities of a country's existing system, and degree of renewables commitment
 - What is essential for one country may not yet / ever be for another
- A country with only very small variable RES penetration, but with the necessary resources to target 10% can look at the "10% Paradigm" to see what this entails in terms of technology development, etc.
- Similarly, a country aiming at 20% or 30% can look at the "20%" or "30% Paradigm"



Technical aspects for discussion



What technologies?

- Variable output technologies: onshore and offshore wind energy, ocean energy, solar photovoltaic, run of river hydro
- High capacity factors technologies: reservoir fed hydro, biomass, concentrating solar thermal (with integrated storage), geothermal
- Storage technologies
- Plant feeding directly into both high voltage transmission, and embedded generation feeding distribution networks
- Hybrid generation, with higher (aggregated) capacity factors
- Demand side response technologies
- Advanced grid operation technologies, power electronics



Factors affecting RES penetration

- Flexible capacity in the generation portfolio
- Available storage capacity available
- Size of balancing area
- Capacity of interconnection with neighbouring systems
- Geographic “smoothing” of output
- Extent of contribution of demand side response measures
- Information technology
- (Resource availability)



Interesting power systems

- Those with high penetrations of inflexible generation, and therefore reduced ability to absorb variable output
- Those with high penetrations of variable output technologies, and high shares of dispatchable fossil fuels
- Those with high proportions of (very flexible) hydropower
- Interconnected systems such as the Nordel system – where, through interconnection, 4 countries benefit from flexible generation portfolio and storage – increasing the size of the balancing area

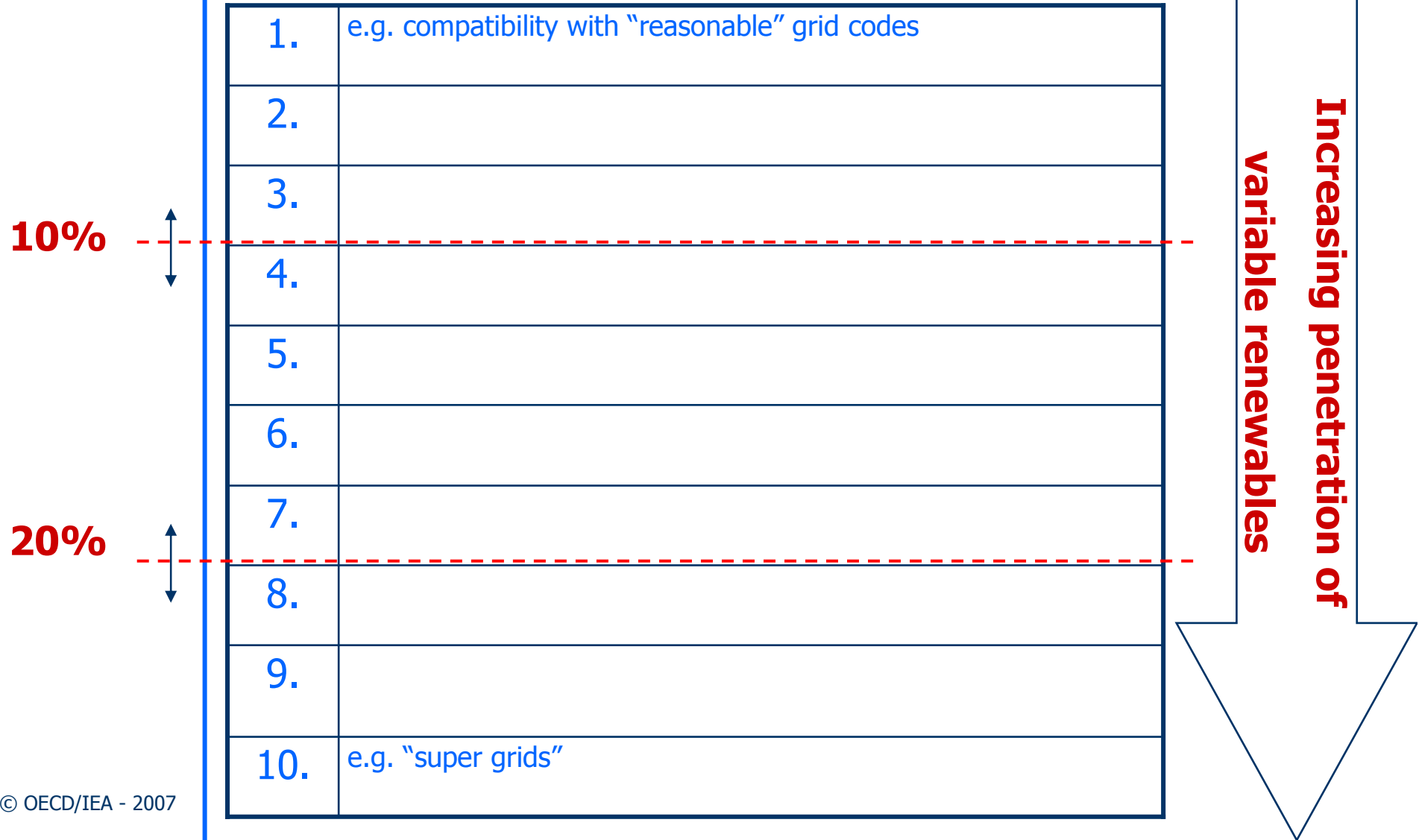


Today's objectives

- Identify challenges that have already been overcome
- Identify the remaining technical challenges and tasks
- Identify which of Paradigms 1 to 5, these challenges and tasks are applicable to.
 - What is essential for one order of penetration may not be necessary for a lower order
- Make an initial, simple list of priority elements with increasing penetration of variable renewables, and relate it to Paradigms 1 - 3



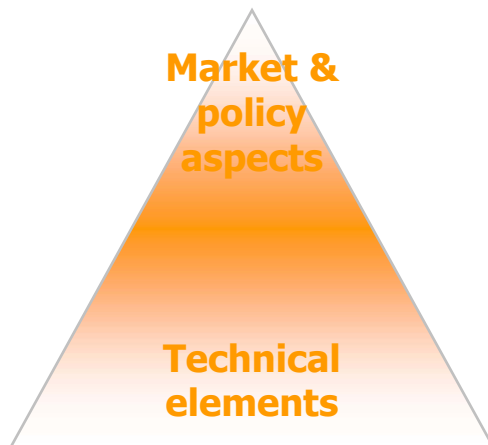
Priority elements as penetration increases



Phase 2 – in the autumn

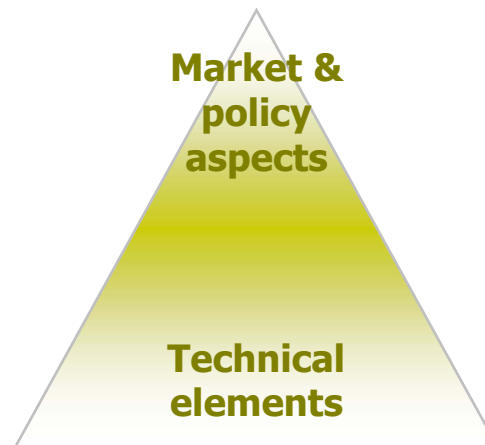
- Market, policy and regulatory aspects will be addressed. The paradigms will then be developed to include these aspects.

“10% Paradigm”



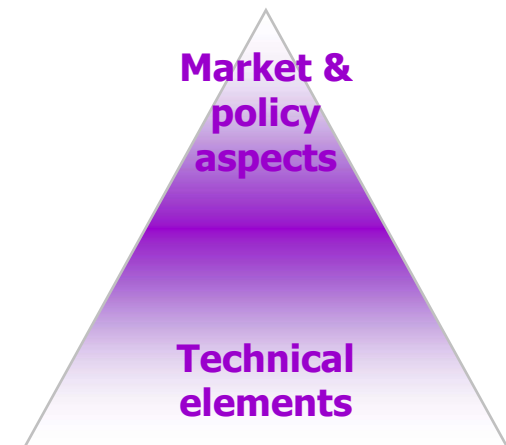
Representing
countries / regions
A, B, C

“20% Paradigm”



Representing
countries / regions
D, E, F

“30% Paradigm”



Representing
countries / regions
G, H



Practicalities

- If you have not yet given me your presentation...
 - Available electronically after the meeting
- Please sign the attendance form, and leave your business card with us
- Coffee breaks in the IEA Bar
- Restaurants map for lunch



Thank you

Contact: hugo.chandler@iea.org