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Renewables & Distributed Generation

Mike Cannon
ALSTOM

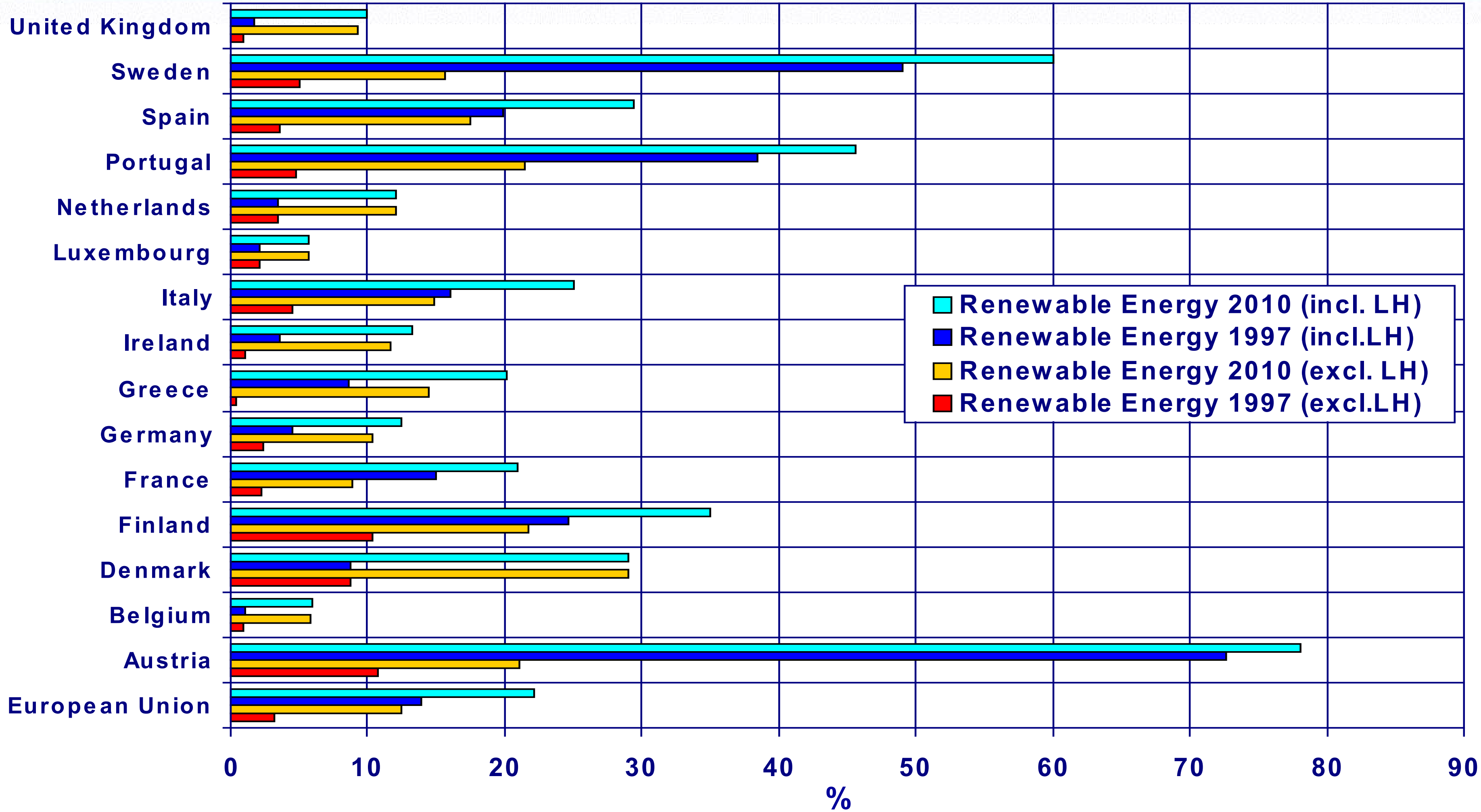
Renewable Energy Technologies

- Mini Hydro (<15MW)
- Wind
- Solar (PV and Thermal)
- Biomass (Solid, Liquid, Gaseous)
- Geothermal
- Combustible Renewables and Waste
- Biofuels (Landfill Gas,…)
- Others (Tide, Waves, Currents ...)

Environmental Issues
Key Developments / Facts

- Several power producers as well as Oil&Gas companies have packaged green power in their portfolio, looking to expand their activities
- Renewable power production will become more competitive due to:
  - Decrease in production costs (increased production level and technical progress)
  - Future economical impact of the marginal costs of carbon abatement
- Use of Renewable Energy Systems (RES) is expected to expand further, supported by implementation of legal restriction framework on emissions

Renewables in Europe
RES Directive 9/2001



Notes: - Renewable Energy Systems (RES) Directive is based on the 1997 EU White Paper (COM(97)599; Nov. 1997)
- LH = Large Hydro (>10 MW)

Biomass-to-Electricity Conversion Efficiency

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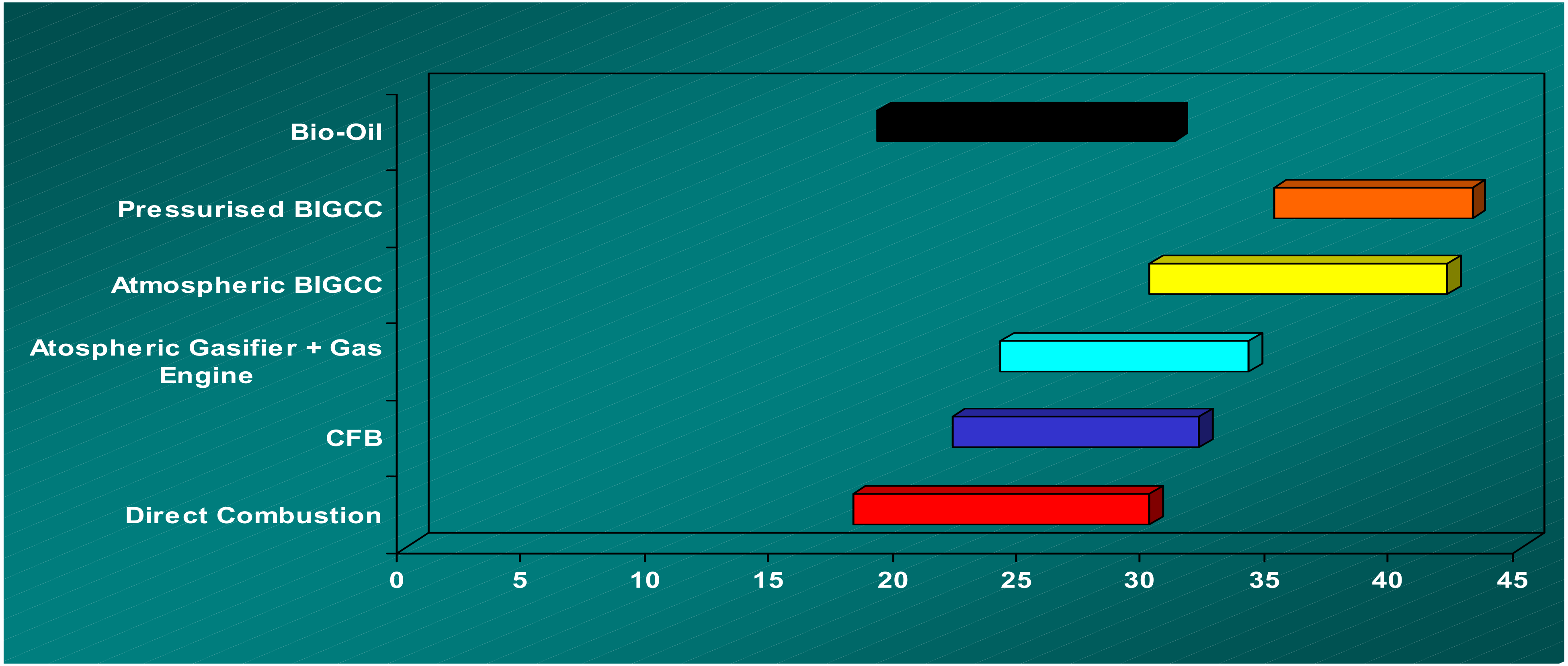
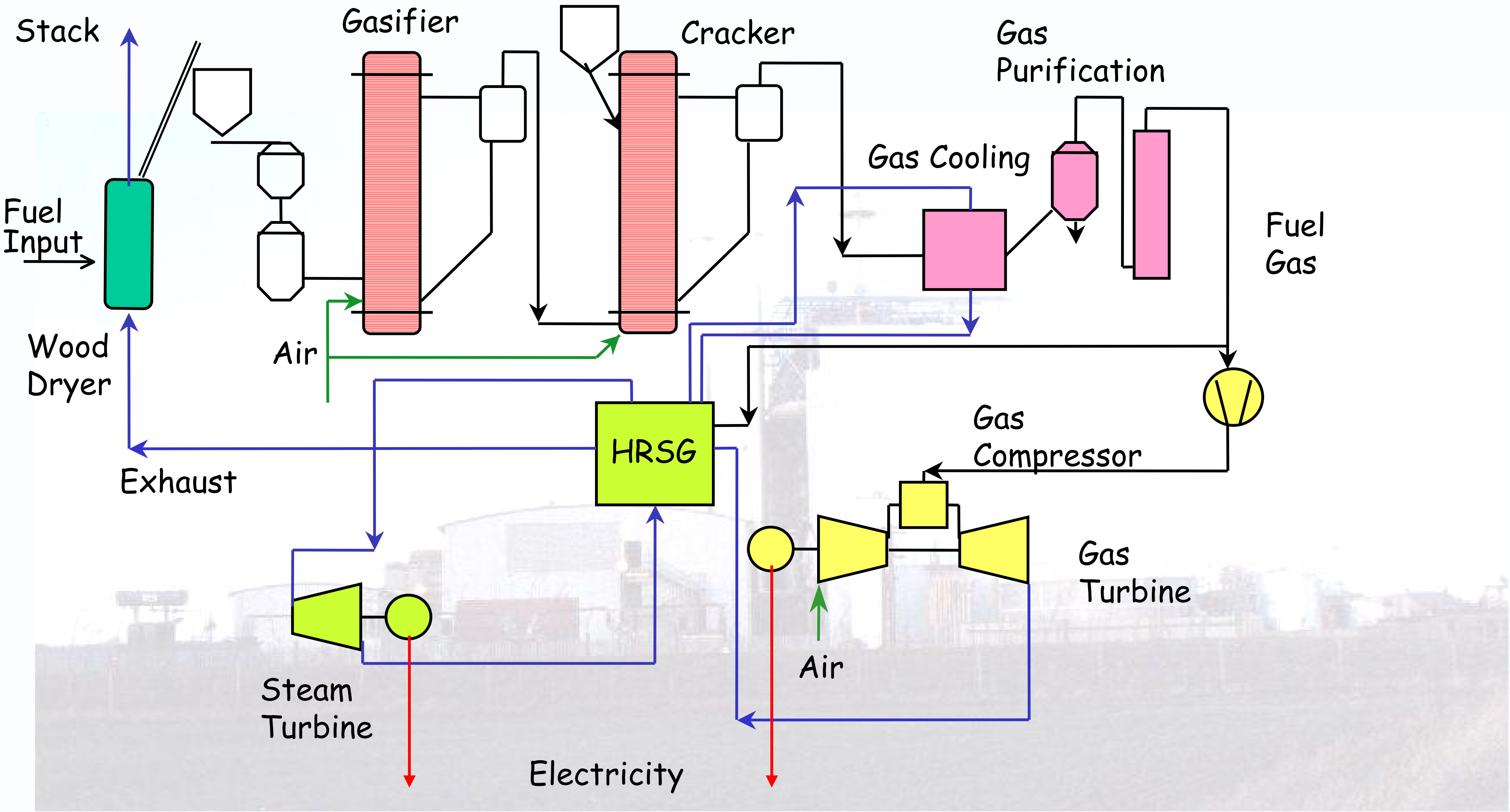
Sub 40MW schemes



ARBRE B-IGCC Process



Harvesting SRF 2002

Primary Support Mechanisms for RES in the EU

- **Guaranteed prices**
  - stand alone tariff or premium on top of market price
  - premium is defined by regulator
  - promotes new renewable capacity addition
  - little incentive to lower costs
  - little adaptations to technological advances
- **Competitive bidding**
  - regulator chooses projects on basis of relative competitiveness
    $\Rightarrow$ less capacity installed, administrative hurdles
  - strong incentives to lower costs
  - firmer control of government spending
  - intensive use of good sites
- **Green Certificates**
  - power sold at prevailing market price and sale of certificates to customers that must demonstrate that a certain percentage of their power is derived from RES
  - incentives to reduce costs
  - prices of green certificates subject to uncertainty

Note: - RES = Renewable Energy Systems

EU Support Mechanisms for RES

One Power Market , 15 Different Approaches

Competitive Bidding	Guaranteed Prices	Green Certificates
	Austria	+ Austria
	Belgium	Belgium
	Denmark	Denmark ?
France	France	
	Germany	
Ireland	Greece	
	Italy	Italy
	Luxembourg	
		Netherlands
Portugal		
	Spain	
	Sweden	Sweden
UK		UK

Note: Finland has no renewable price support system

Source: CERA

Future Electric Systems: Decentralized & Distributed Power Supporting the Grid

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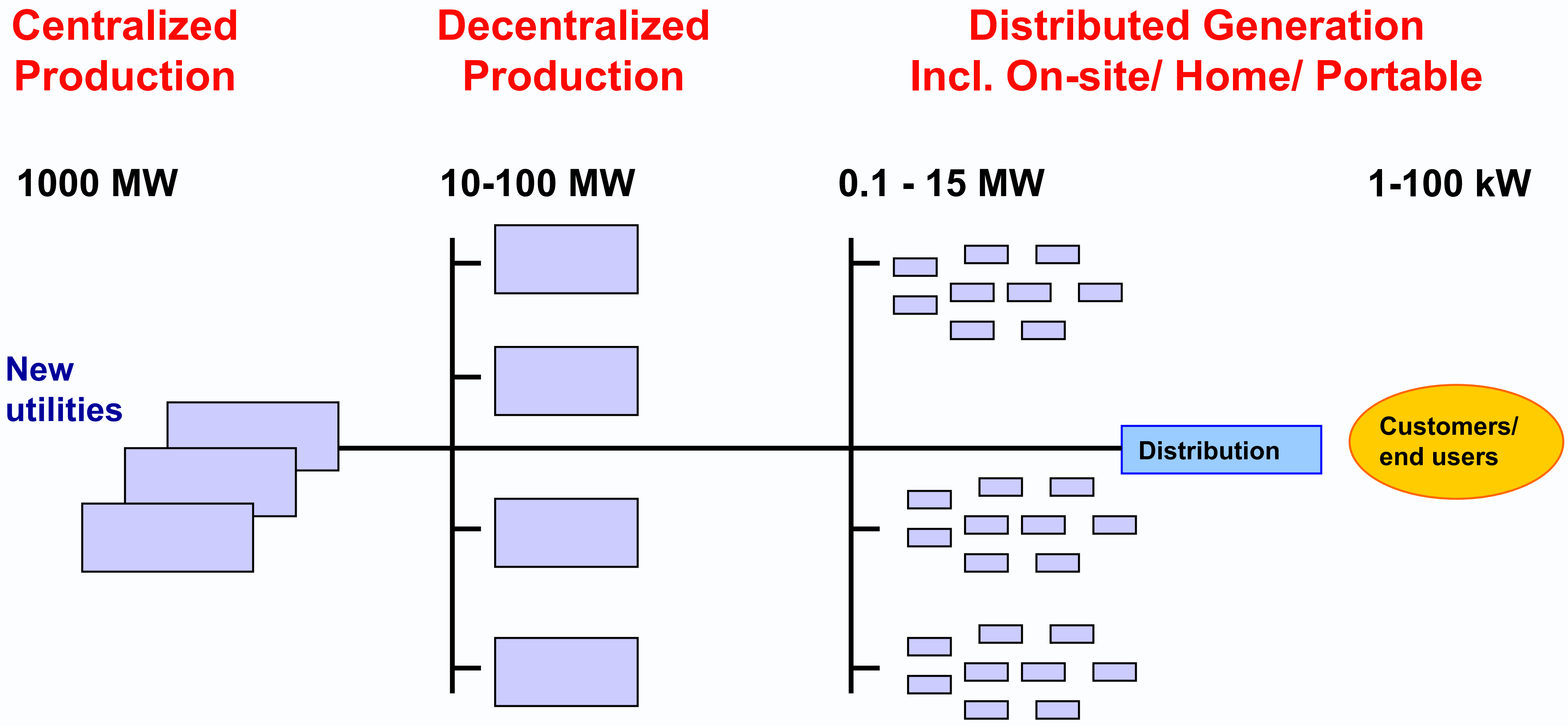

Distributed Generation Technologies and Applications

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DG Technologies

- Incumbent:
  - Reciprocating engines (diesel, gas)
- New Technologies:
  - Stirling engines (conv., new concepts)
  - Combustion turbines (industrial, mini, micro)
  - Fuel Cells (PAFC, SOFC, MCFC, PEM)
  - Photo Voltaic

New renewables:

- Wind (site dependent)
- Geothermal (site dependent)
- Biomass (fuel issue only)

Applications

- Stand by
- Peak shaving
- Grid support
- Stand alone (grid isolated)
- CHP + cooling
- Energy Rental (temporary mobile power)

Distributed Generation: Market Drivers and Implications

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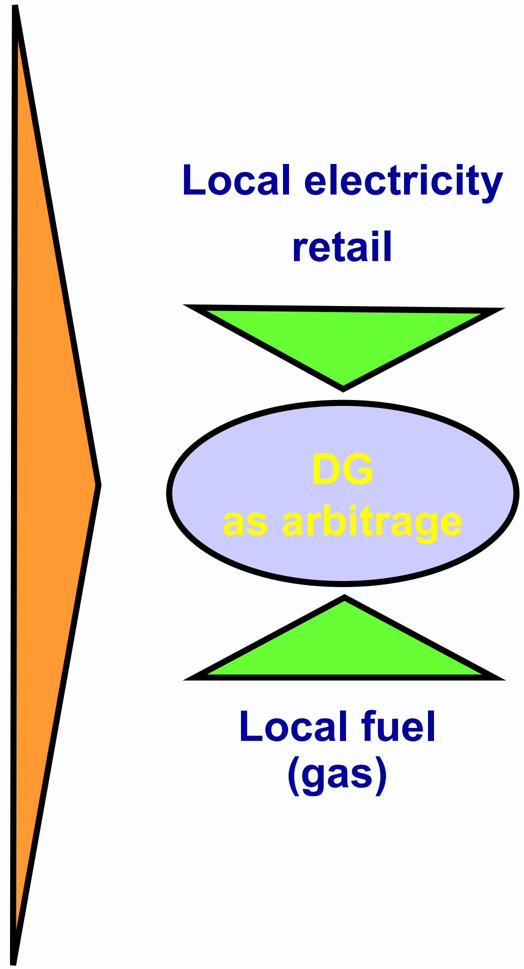
- **Increased liberalization (at wholesale and retail level)**
  - ➔ intense price volatility
  - ➔ more customer choices
  - ➔ new offerings by unregulated retailers
- **Transmission bottleneck and "gridlock" (USA)**
- **Growing technology improvements in small size PG**
  (in different phase of commercialization)
- **Evolving environmental requirements and regulatory incentives**



➔ **New:**
Multi offerings, Enterprise energy management, ...

➔ **Existing:**
Power distribution & fuel distribution companies, both become also active DG providers

Renewable Energy and DG - Summary

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- RES percentage increasing
  - generally generation units <40MW
  - compatible with DG expansion
  - needs to demonstrate cost reductions
  - wind, solar, ocean, biomass and EfW are all important
  - needs significant support in the short/medium term
- Drivers supporting DG growth are identified but crystal ball still cloudy
  - Deregulated market not stimulating investment
  - Micro generation technologies still emerging
  - Distribution management rules & technology not developed
  - Fuel supply and carbon management issues unclear

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