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Energy innovation for a real world: from science to society

Barcelona Global Energy Challenges

19th of June, 2014

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Innovation and Technology Support

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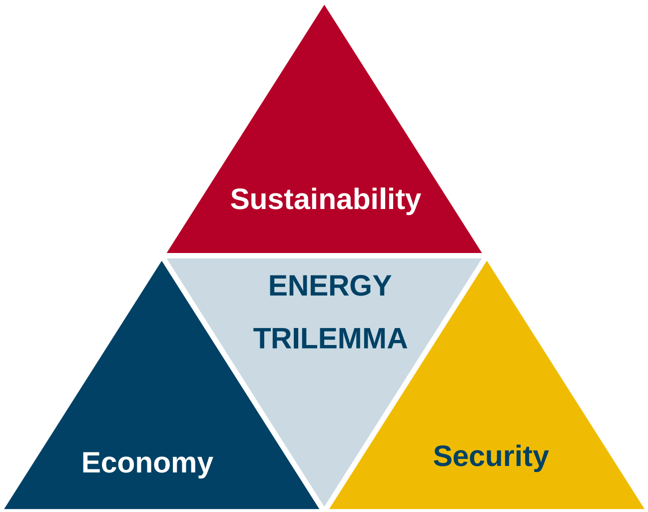
Energy trilemma

Underlying reasons to innovate in energy



DAY TO DAY CHALLENGES:

- **Incorporate new facilities** according to criteria of efficiency-economy, long term sustainability and balance of technological risks
- **Optimise** of the O&M in existing facilities
- **Improve** the quality, reliability, safety and efficiency of energy supply
- **Meet the energy needs** of customers, helping to create high value for them and hence a satisfactory relationship
- Promote **new products and services** in the field of energy, expanding markets and building a more advanced society

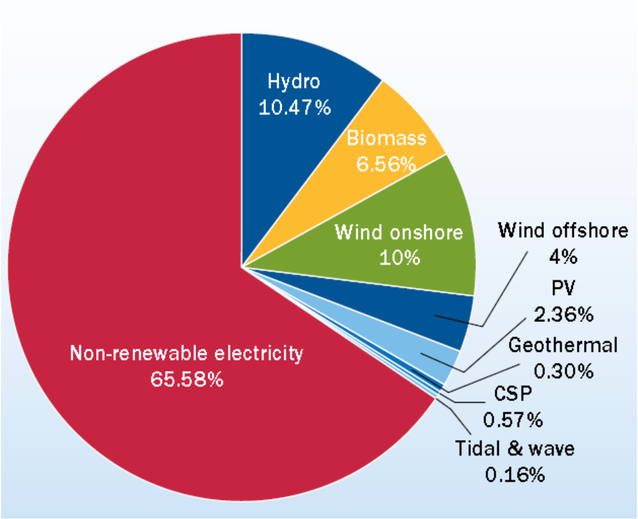
BUT…the real technological challenge lies not in reaching a compromise of reliability, sustainability and economy, but in advancing simultaneously on all three aspects

The big one in the long term is being able to provide very cheap and available energy, with almost environmental impact: fill the whole triangle

Energy trilemma

Security

EU Electricity mix in 2020 (share of total consumption) – total 3,537.3 twH



Source: EWEA, EU Energy Policy to 2050

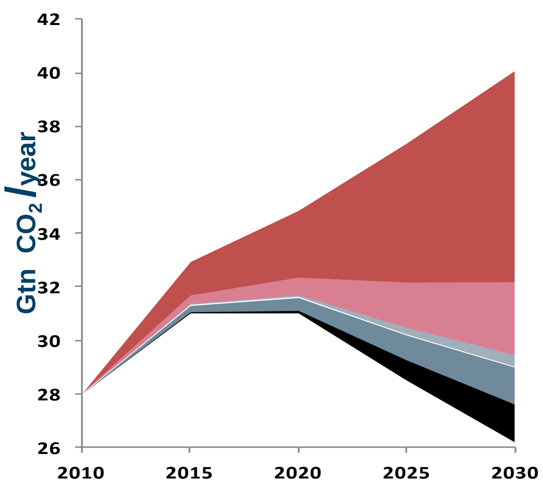
- **Dependency of supply:**
  - Energy dependence (80% Spain; 70% Europe)
  - Increasing energy demand
  - Renewable resources integration
  - Distributed generation integration
  - Diversification and new fossil fuels sources and supply
- **Reliability of supply:**
  - Resilience in energy system, grids and facilities
  - Utilization of low-manageable (today) renewable resources together (tomorrow) with storage
  - Supra-smart: interconnectivity of energy systems or smart *electricity&gas* (and probably also transport) grids

Although cheap and sustainable energy is most desirable, the first concern of a energy user is to enjoy the use of energy as required

Energy trilemma

Sustainability

CO_2 emission abatement vectors



CO_2 Gtn in IEA reference scenario (upper line) and tentative reductions due to:

Efficiency:

- **Smart grids.**
- **Viable distributed generation.**
- **Efficient use of energy.**
- **Efficient transportation.**

Renewable energy

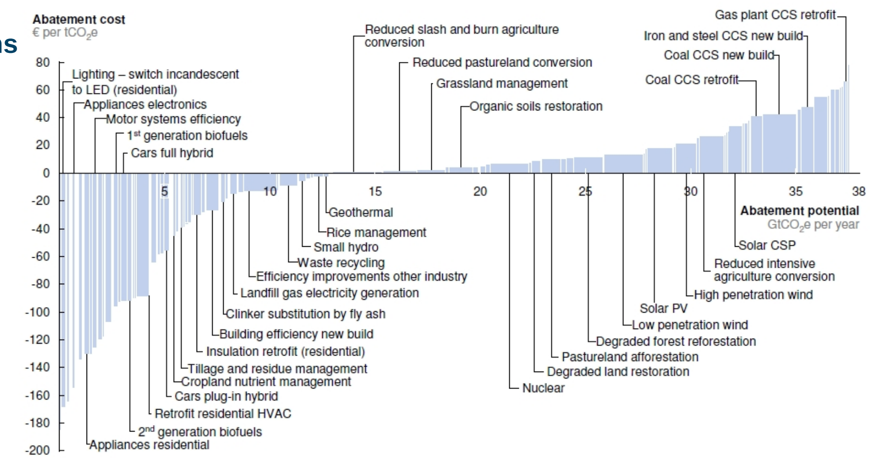
Bio fuels

Nuclear

CO_2 capture and storage

Source: IEA " How the Energy sector can deliver on a climate agreement in Copenhagen"

Global GHG abatement cost curve 2030



Source: McKinsey & Company

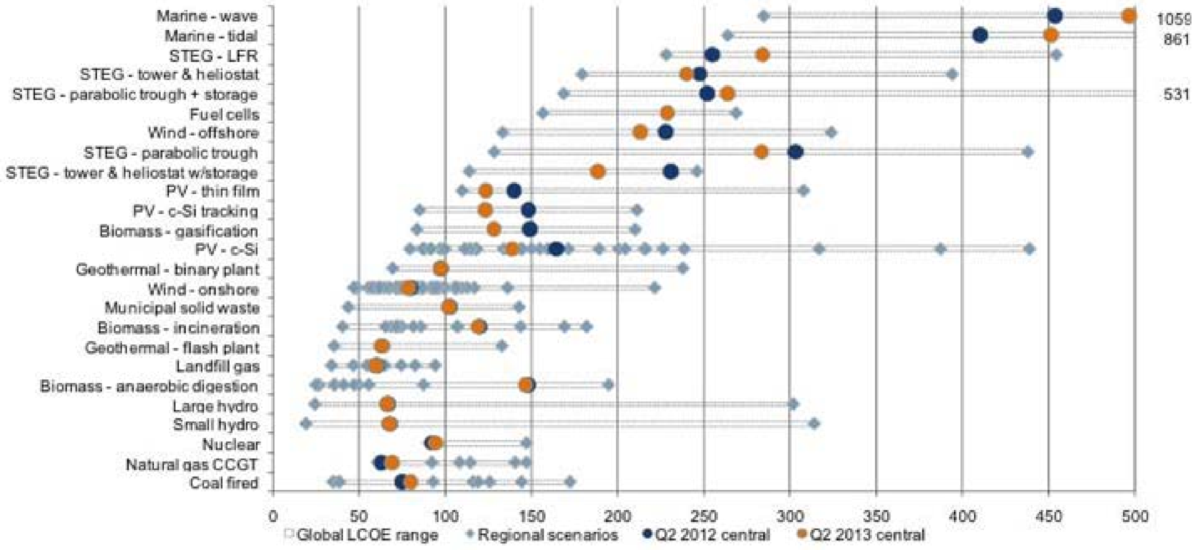
- It is commonly agreed that in mitigating climate change none of these strategies is enough when unit by unit (marginal cost analysis) is installed
- At a cost of 40 €/tnCO_2, potential abatement by 2030 is estimated over 30 Gt CO_2-eq/year
- Energy saving and efficiency -> negative abatement costs!...but only compared to BAU.

Easy to say, sustainability is supposed to be a key drive for innovation in energy

Energy trilemma

Economy

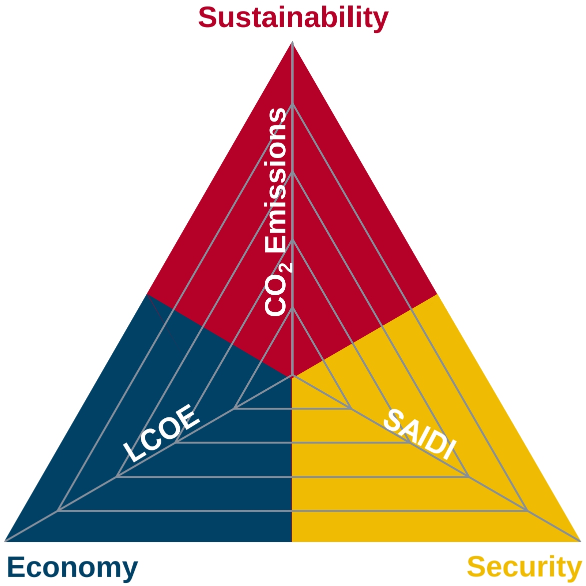
Levelized Cost Of Electricity (LCOE) over time

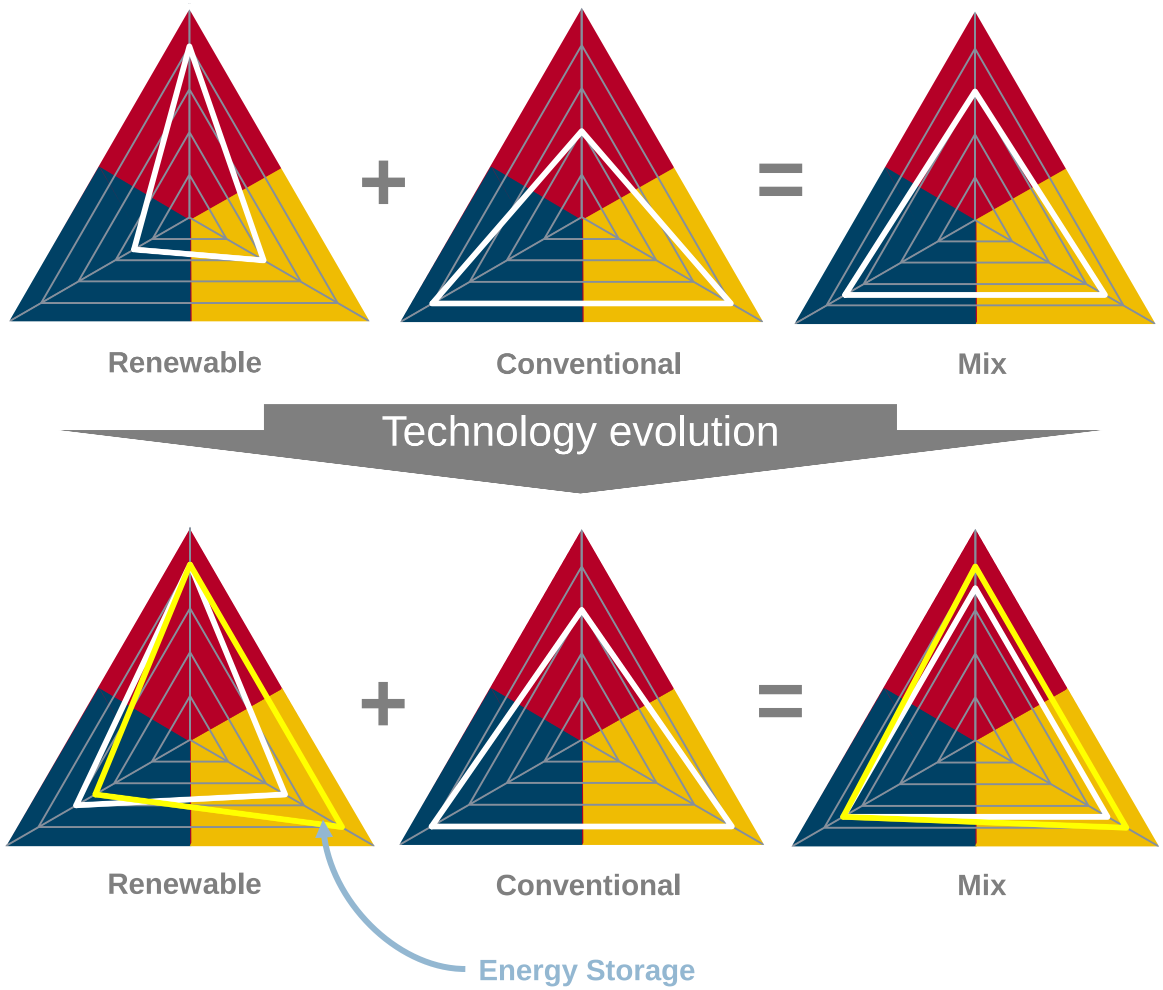


Source: Bloomberg New Energy Finance

LCOE provides a sound basis for comparison in economics, although often hides key questions to decision makers. Life-time and CAPEX/OPEX considerations are critical in specific regional analysis

Energy trilemma





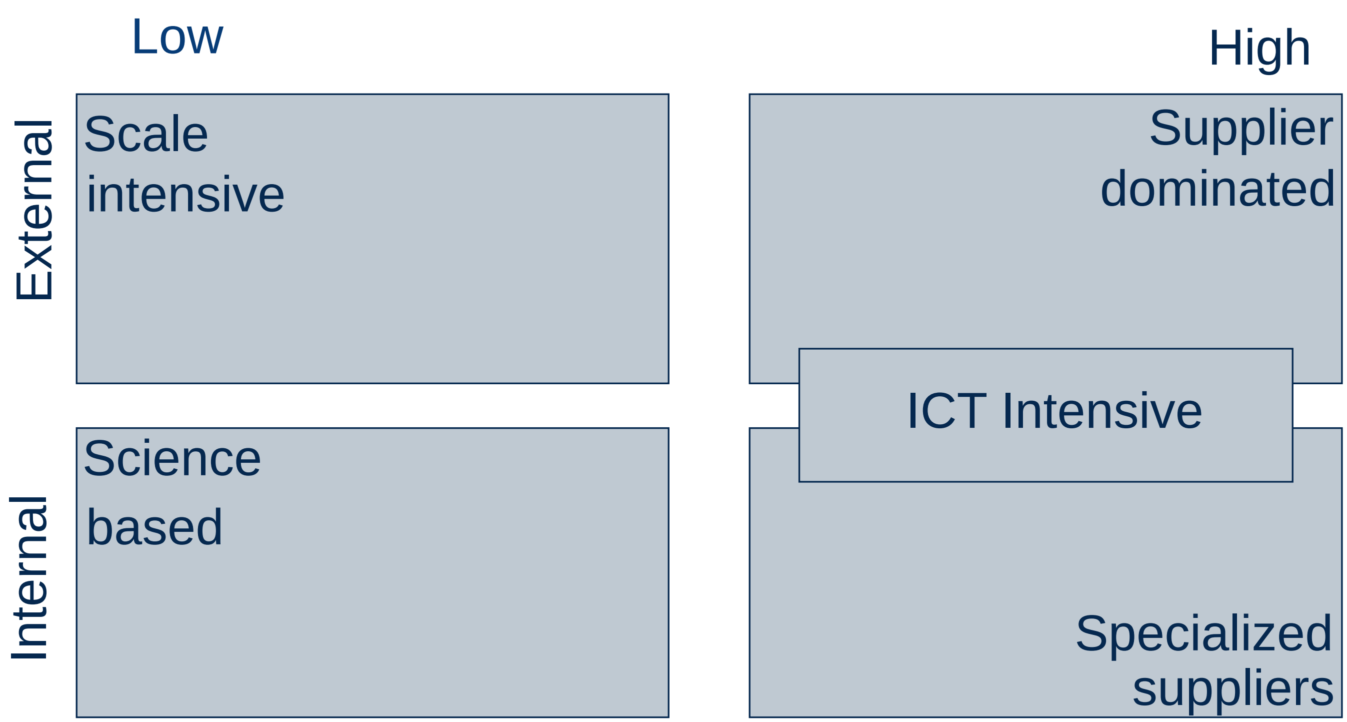
LCOE – Levelized Cost of Electricity
SAIDI – System Average Interruption Duration Index

Energy innovation as a process

Pavitt’s taxonomy – Who intervenes and why

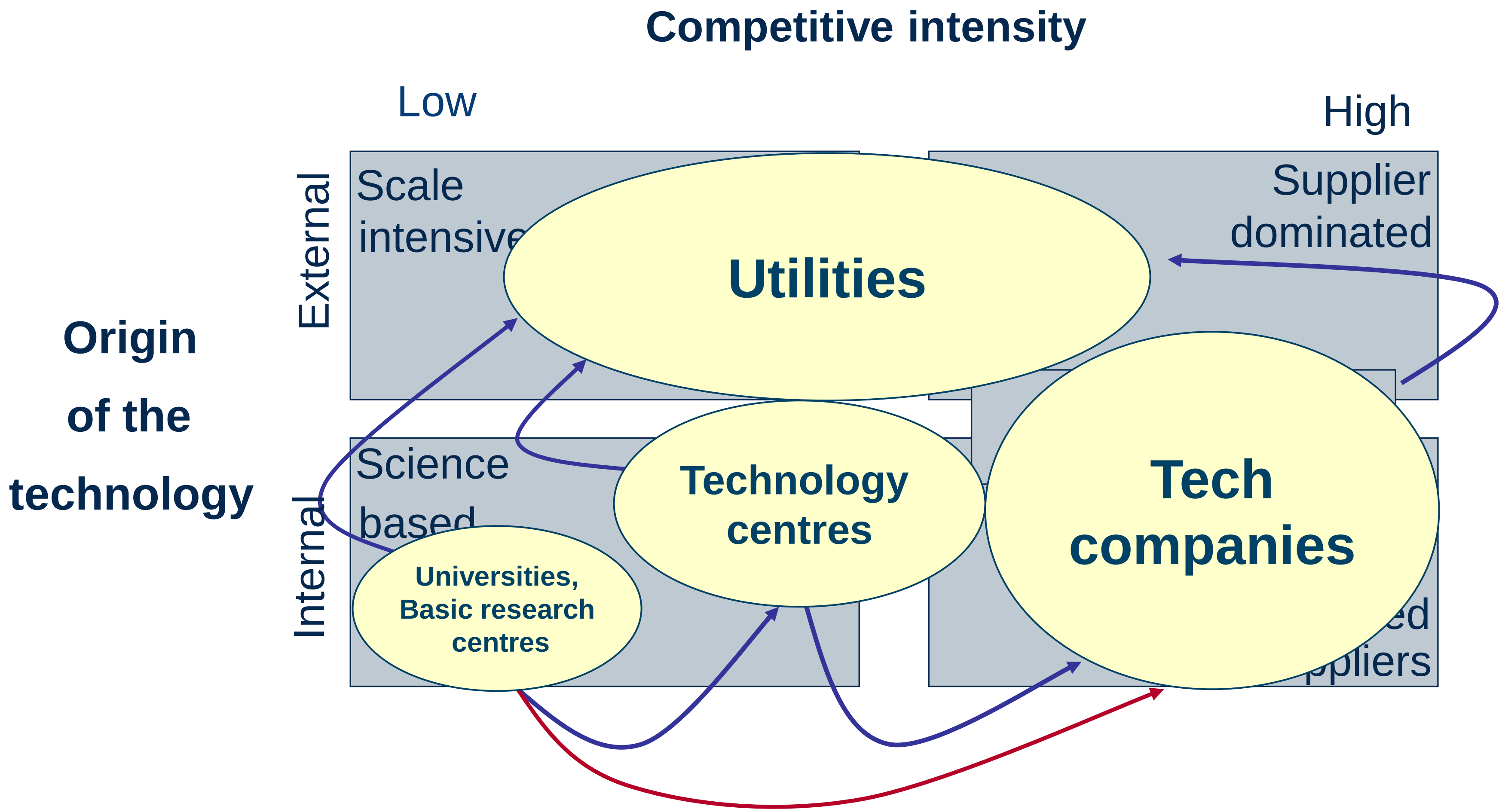
Competitive intensity

Origin of the technology



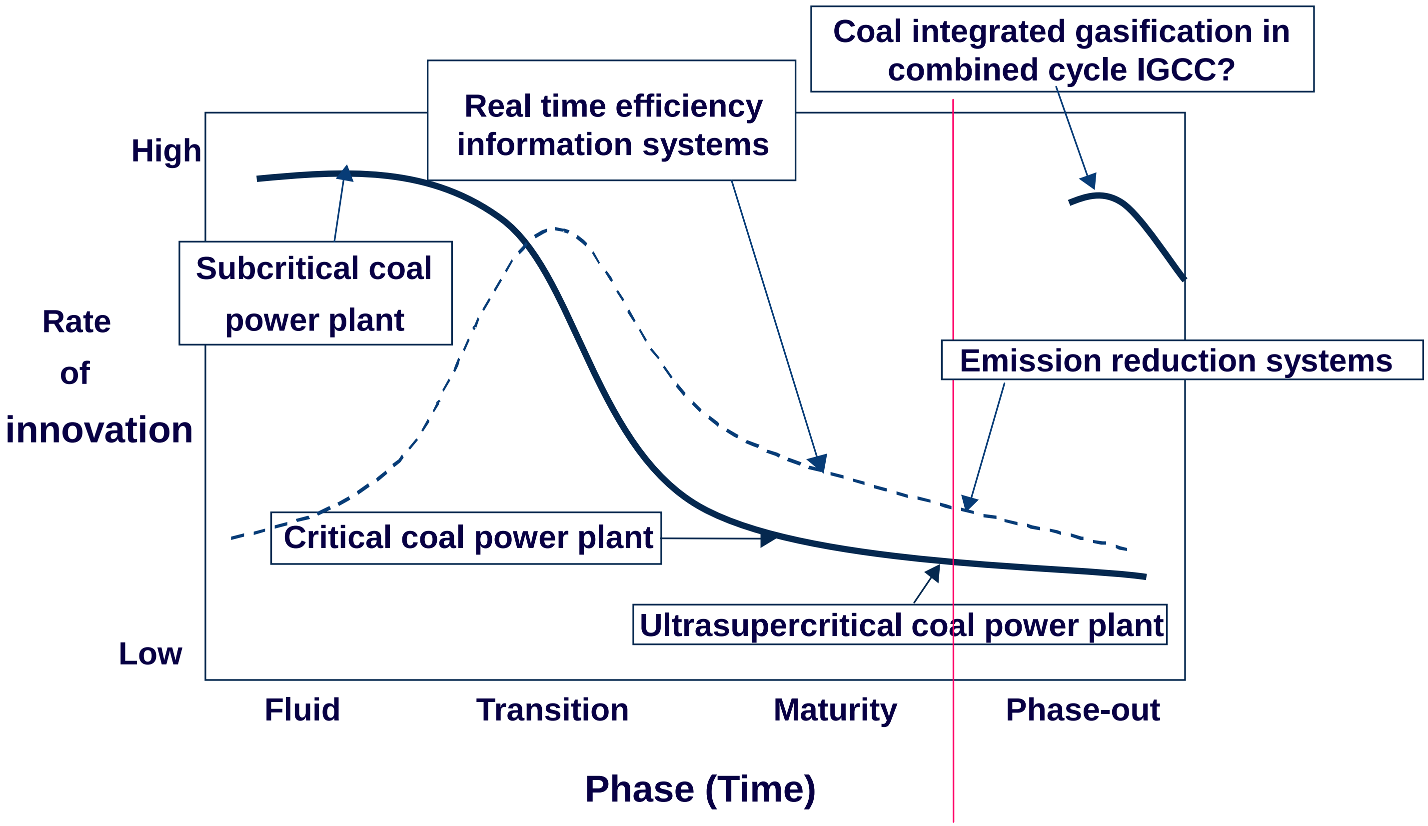
Energy innovation as a process

Pavitt's taxonomy – Who intervenes and why



Energy innovation as a process

Utterback's model of product and process innovation

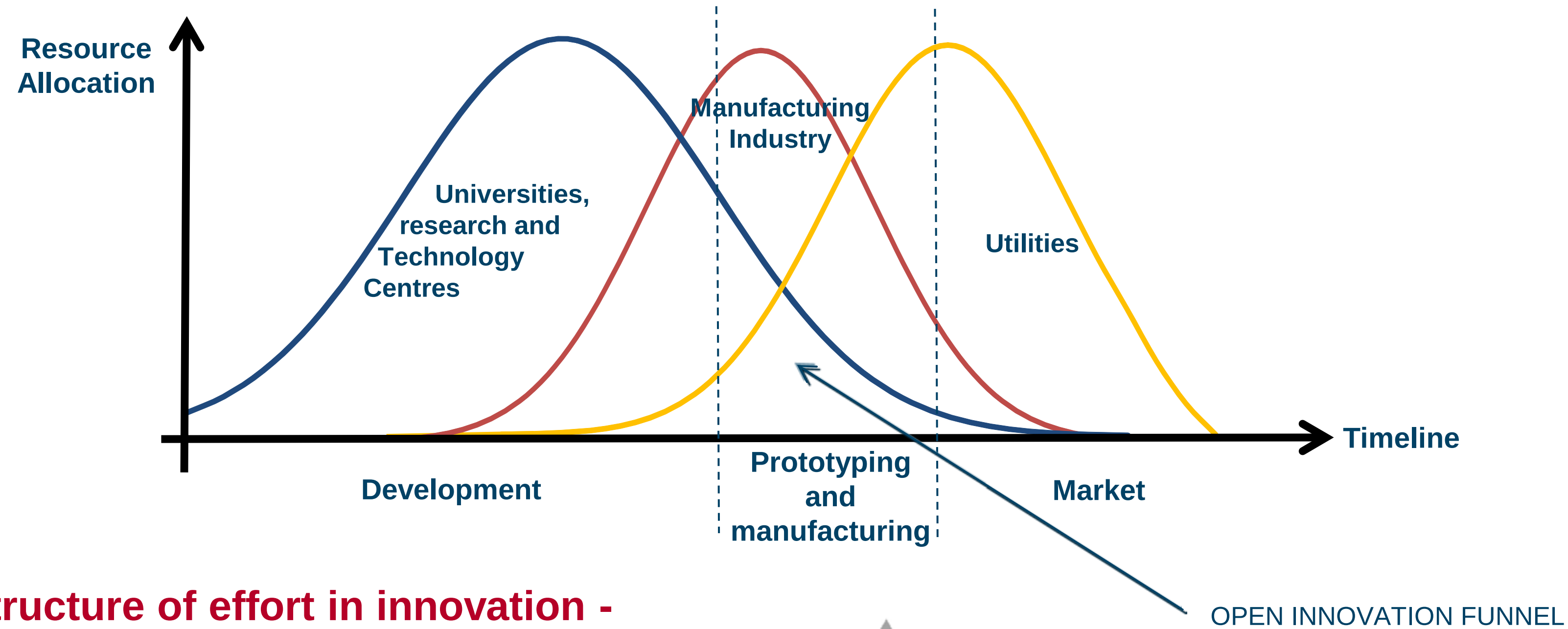


Cycles in energy are medium to long, thus defining the roles of the intervening agents:

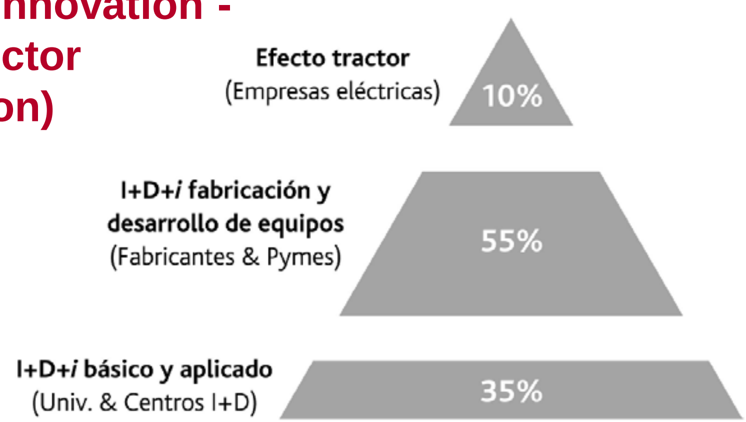
- Utilities: present facilities
- Technology supplier: future facilities

Energy innovation as a process

Resource allocation in energy innovation



Structure of effort in innovation - Spanish electricity sector (distributed by function)

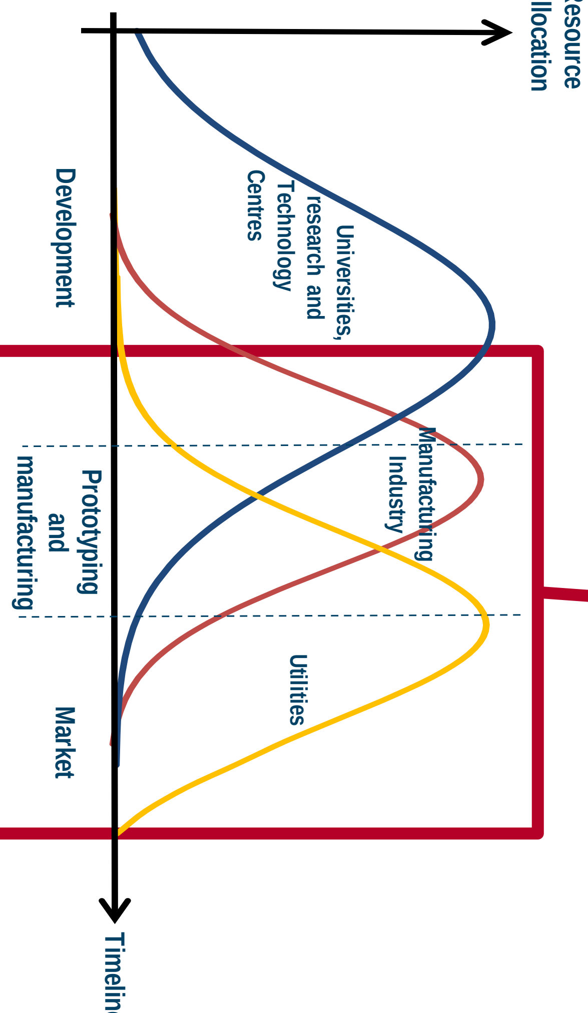


Ref: UNESA: Report "I+D+i de la electricidad en España 2008"

Forecasting the success

Technology Readiness Level

Level	Technology Readiness Level – TRL
1	Basic research. Basic principles observed.
2	Applied research. Technology concept formulated.
3	Applied research. Experimental proof of concept.
4	Technical verification & demonstration. Technology validation in laboratory environment.
5	Technical verification & demonstration. Technology validation in relevant environment.
6	Technical verification & demonstration. Demonstration in relevant environment.
7	Technical verification & demonstration. Demonstration in operational environment
8	Technical verification & demonstration. Technical system completed and qualified.
9	Large scale & successful deployment. Successful commercial deployment



Impact in the real world

TRL.-Technology Readiness Level concept, originally developed by NASA [1980s], with evolution and adaptations to different purposes

Forecasting the success

Other Readiness Levels

Level	Customer commitment - CRL
1	None.
2	One or more customers provide informal information to the business on technology evaluation and product requirements.
3	One or more customers commit minor resources
4	One or more customers commit limited resources (such as labor & materials for evaluation & feedback).
5	One or more customers commit moderate resources (such as prototype testing).
6	One or more customers commit substantial resources (such as operational environment testing or cash for R&D) .Customer has urgent and compelling reason (improve competitive position, avoid obsolescence, meet minimum performance requirements) to adopt the product.
7	One or more customers committed to purchase quantities requiring Low Rate Initial Production.
8	One or more customers committed to purchasing quantities requiring full rate production.
9	One or more customers committed to long-term supply agreements that require full rate production.

Technology Readiness Level concept applied to other factors, mainly:

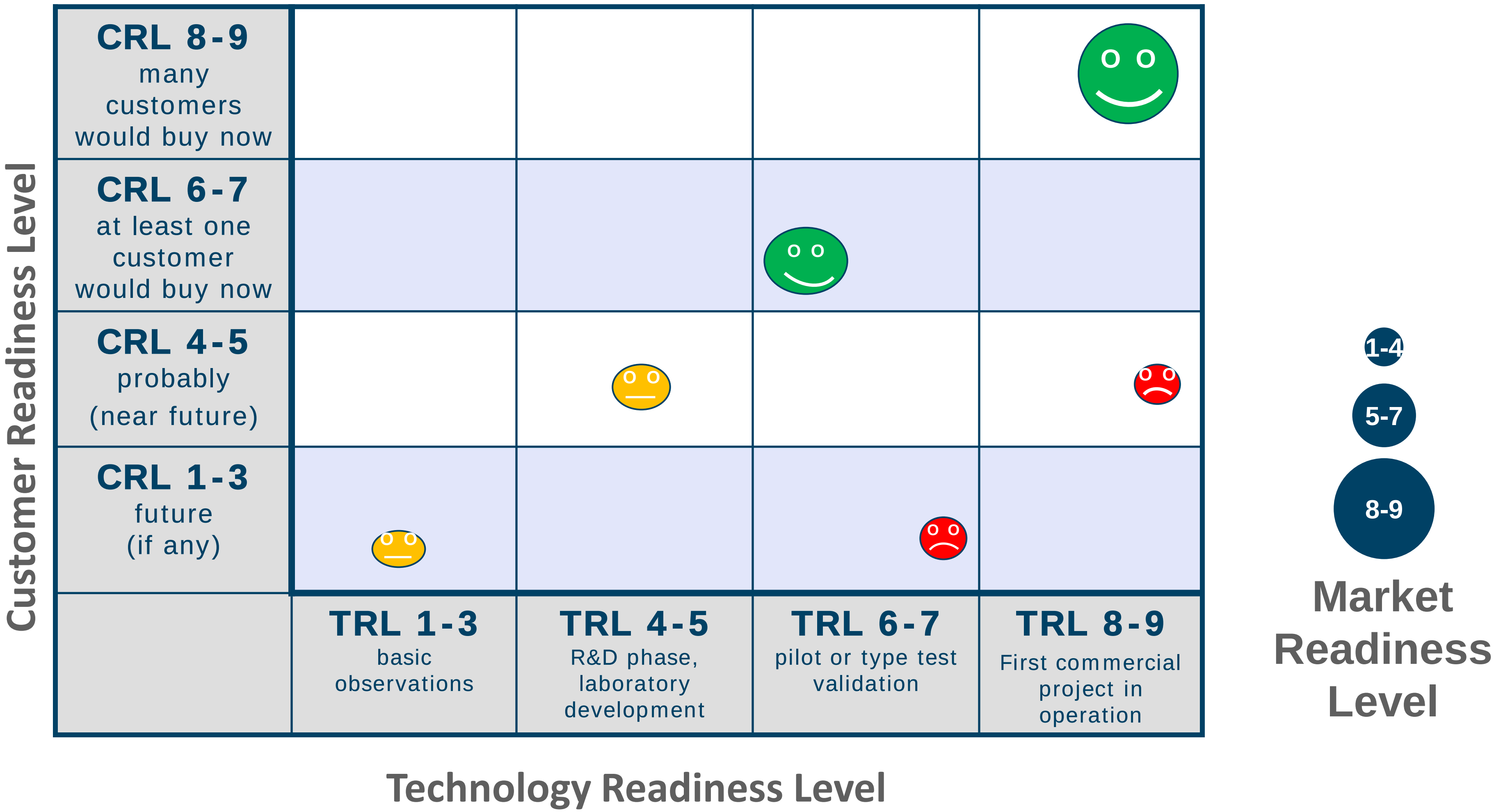
- Commercial or customer commitment readiness
- Market readiness

A good technology on its own also requires a suitable environment to thrive

Level	Sales Forecasts - MRL
1	Highest. Forecast is based on assumptions only.
2	Extremely high. Forecast is based on assumptions and broad industry data.
3	Very High. Forecast is based on assumptions and loosely targeted industry data.
4	High. Forecast is based on growth models with uncertain validity and well-targeted industry data.
5	Medium – High. Forecast is based on credible sales growth models and well-targeted industry data. Customers have expressed strong interest but made no purchase commitment.
6	Medium. Forecast is based on early sales, credible sales growth models, and reliable industry data. Business has a strong position in a small niche market.
7	Medium – low. Forecast is based on actual sales. Business has a strong position in a niche market.
8	Low. Forecast is based on actual sales and a moderate order backlog. Business is no lower than 3rd in market share and has sustainable competitive advantage.
9	Extremely low. Forecast is based on actual sales and a large backlog. Business has dominant market share and distinctive sustainable competitive advantages.

Forecasting the success

Mapping



Forecasting the success

Relevant questions

IS THE TECHNOLOGY READY?

- Well developed
- Attractive to customers
- …

IS THE WORLD READY?

- Regulation in place
- Society positive perception
- …

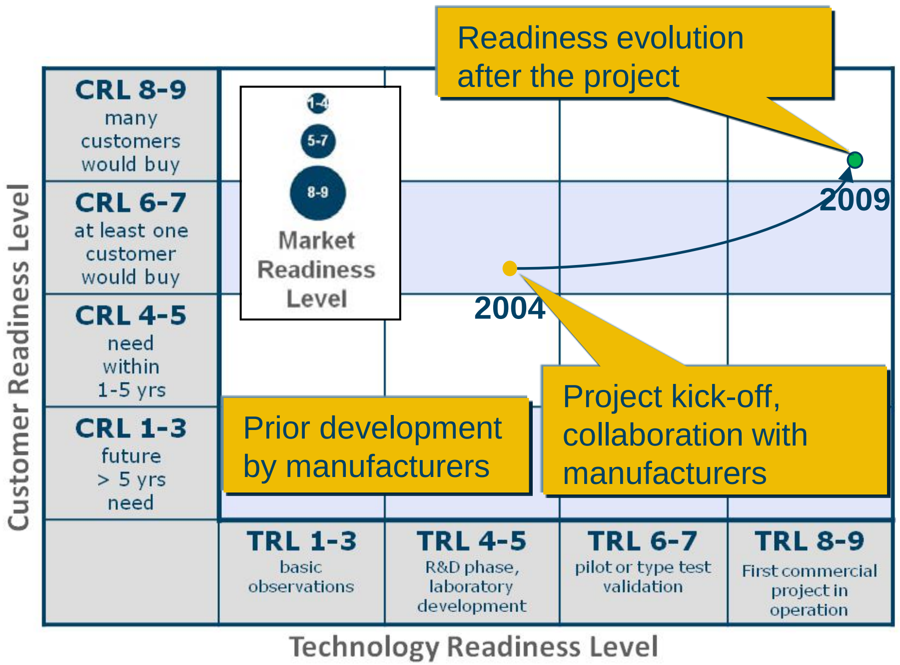
Successful innovation in energy requires the transformation of available knowledge into new, marketable products and services in a social favorable environment with sound legal rules

Some innovation cases

AWEC60 / TOLEDO PV

Some innovation cases

Mobile transformer for emergency / maintenance purposes



Project collaboration with manufacturers to integrate existing and proven technologies to address the specific need:

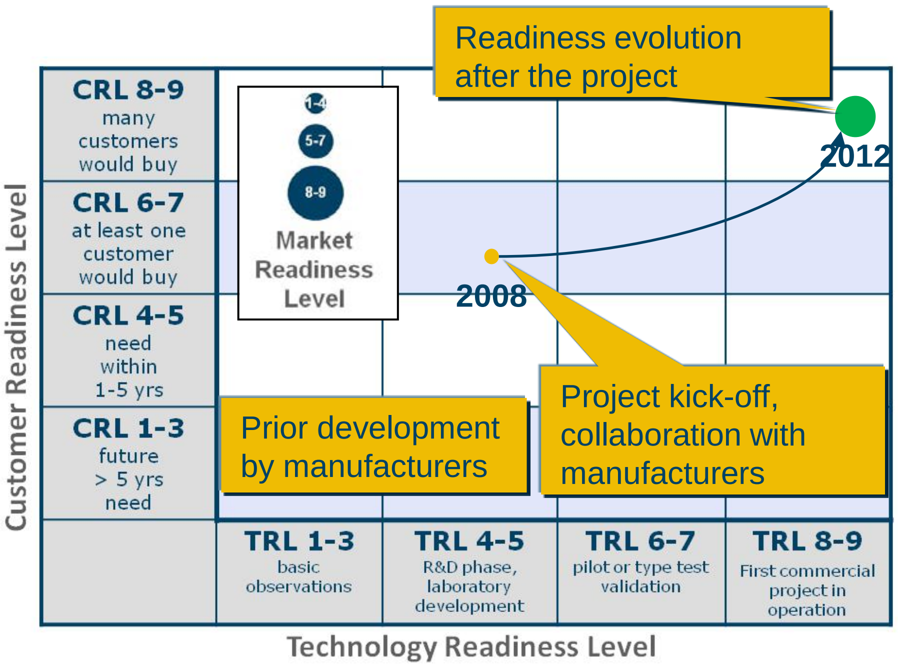
- Mobile Substation 45-15kV 25 MVAs
- Mobile substation connection and switching 132kV or 66kV
- Mobile transformer132-66 20-15 30MVAs
- Mobile transformer132-45-30MVAs

Reliability of supply driven innovation

Utility promoted development, due to the reduced market size

Some innovation cases

Natural gas modular fuelling station



Project in close collaboration with manufacturers to integrate existing and proven technologies to create a new fuelling facility

Sustainability driven innovation – Shift to natural gas

Utility promoted development, as an ignition point for further development

Conclusions

Energy and society

- Energy, together with water and communications is the back bone of the society
- The challenge in energy is to expand simultaneously the trilemma triangle in its three corners: cheap and available energy with near-to-zero environmental impact
- Energy field is a good example to open innovation funnel, where utilities main function is pushing tech companies and other tech actors to new developments
- Not only technology maturity matters. Commercialization and a favorable environment (legal and social) are also equally important
- All energy options are (and probably keep) open in some kind of theory game race. Thus we do believe that energy is more than ever an interesting technological battle field to brilliant people to devote their talent.

Thanks.
Muchas gracias

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