Diffusion of energy technology innovations in Portugal and perspectives for decarbonization

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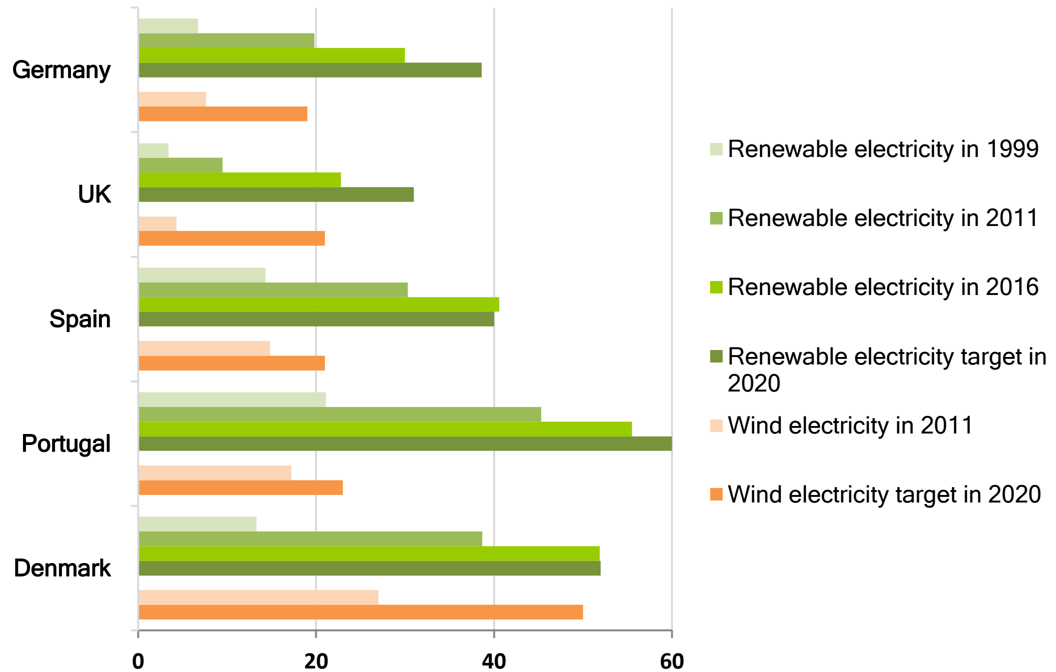
[a] iscte UNIVERSITY INSTITUTE OF LISBON dinamia'cet_iscte

[b] LNEG Laboratório Nacional de Energia e Geologia, I. P. REPÚBLICA PORTUGUESA ECONOMIA HR EXCELLENCE IN RESEARCH

Portugal has been a fast follower in the energy transition

Share of RES in Gross Final Electricity Consumption (in %)



Sources: DGEG (2013, p.12); National Renewable Energy Action Plans (NREAPs) of the European Member States: Beurskens et al.(2013, Table 3 and 10a/b); Ren21 Map <http://map.ren21.net> (accessed in September 17, 2013); Plano Nacional de Accão paraas Energias Renováveis (PNAER in Resolucão do Conselho de Ministros no. 20/2013, 10 April), Eurostat, 2018.

OUTLINE

I. DIFFUSION OF ENERGY TECHNOLOGIES IN PORTUGAL

II. CONSTRUCTION OF A LOCAL INNOVATION SYSTEM AROUND NEW ENERGY TECHNOLOGIES

III. MEETING THE CHALLENGE OF DECARBONIZATION BY 2050

3

I. Diffusion of energy technologies in Portugal

A. DETERMINANTS OF THE DIFFUSION RATE

- relative advantage
- size of potential market
- disruptiveness (existence of antecedent markets)
- technological complexity
- infrastructure needs

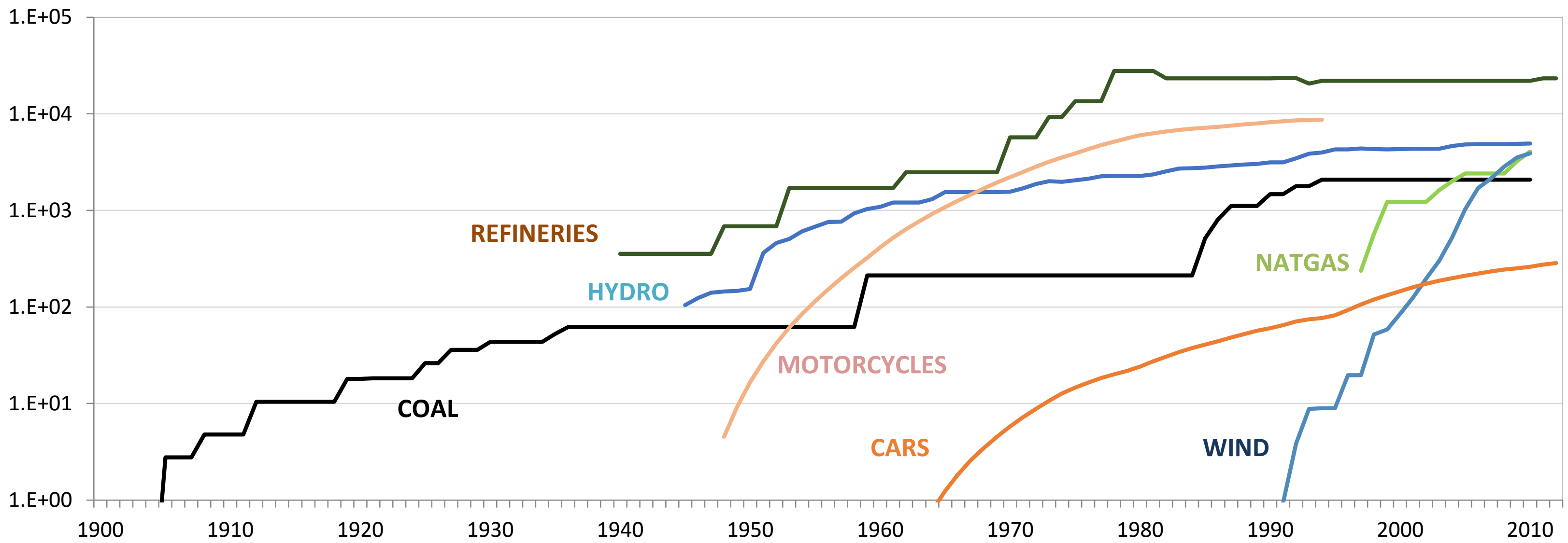
Rogers, E. M. (2010). *Diffusion of innovations*. Simon and Schuster.
Grubler, A., & Wilson, C. (Eds.). (2014). *Energy technology innovation*. Cambridge University Press.

B. HISTORICAL DIFUSION OF ENERGY TECNOLOGIES IN PORTUGAL

- technology diffusion is a slow process

Technology diffusion is a slow process

Cumulative installed capacity (MW) of several energy technologies in Portugal since 1900, log y-axis



Bento, N., & Fontes, M. (2016). The capacity for adopting energy innovations in Portugal: Historical evidence and perspectives for the future. *Technological Forecasting and Social Change*, *113*, 308-318.

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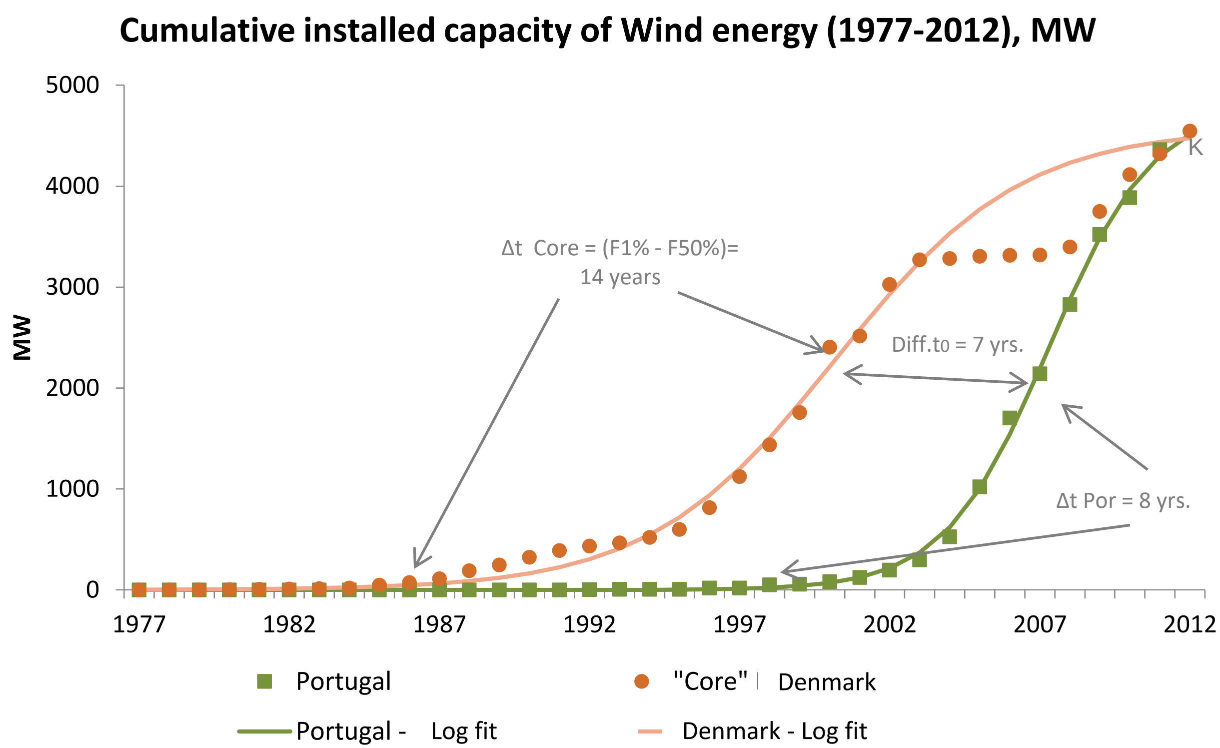

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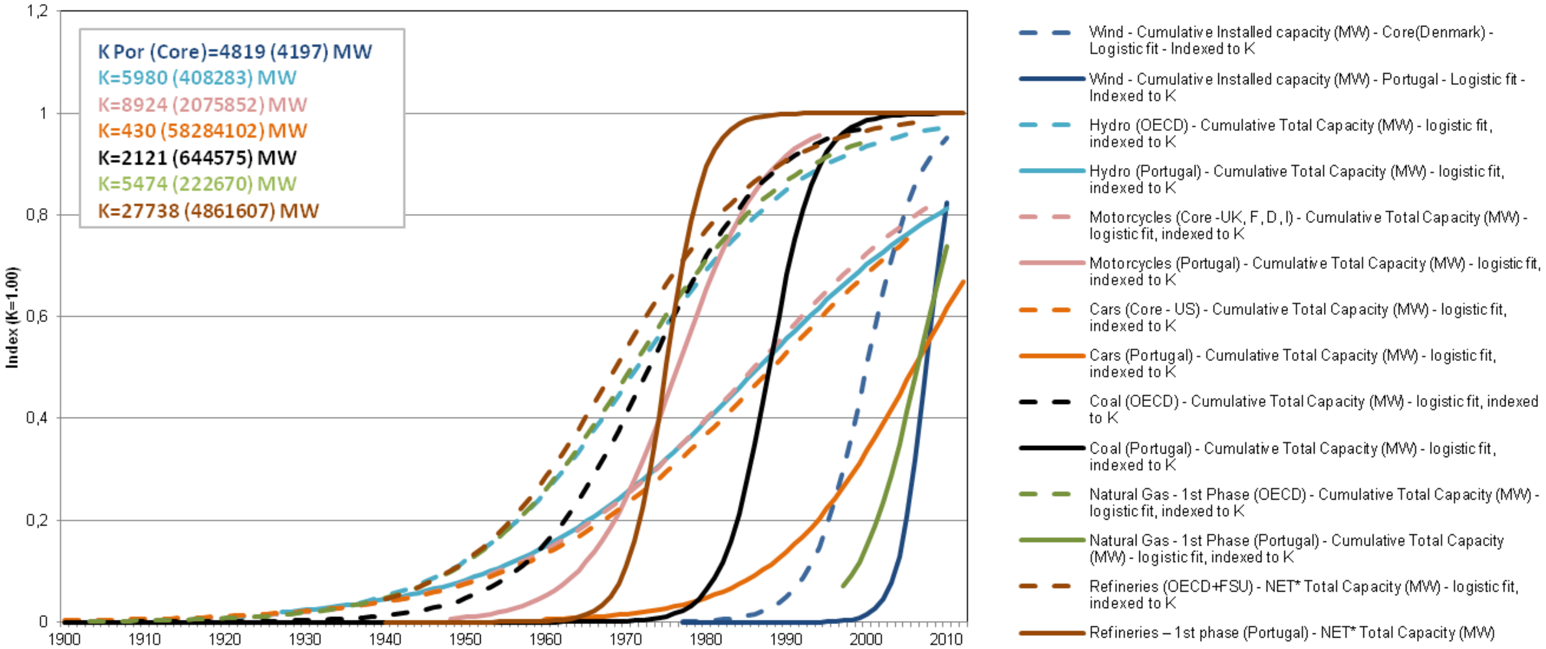
Speed of diffusion accelerates in comparison with the “core”

All technologies (Portugal vs Core) – Cumulative installed capacity, Log fits, Indexed to k=1.00



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	chnological factors					Structural requirements				
Technology	**Relative advantage (price/cost**	**Technology pervasiveness (market size)**	**Technology disruptiveness (or substitute)**	**Technology Complexity**	**Infrastructure needs**	**Actors (value-chain)**	**Networks (diversity)**	**Institutions (laws, conducts..)**	***Diffusion (years)****	***Delay for the Core (years)***
Oil Refineries	++	––	.	-	·	+	+	.	*10*	*6*
Power – Coal	+	–	-	.	–	.	.	-	*13*	*15*
Power - Hydro	++	––	-	.	–	.	.	--	*66*	*15*
Power -Nat.Gas	+	–	++	+	––	+	+	-	*16*	*35*
Power - Wind	--	–	++	-	+	-	--	-	*8*	*7*

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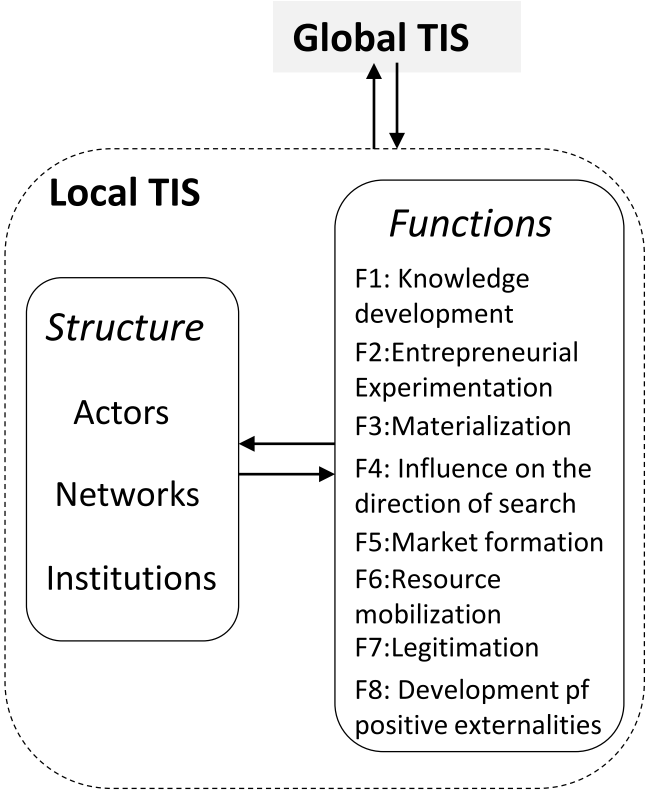
II. Construction of a local innovation system around new energy technologies

A. TECHNOLOGICAL INNOVATION SYTEMS: FUNDAMENTAL ELEMENTS



Binz, C., & Truffer, B. (2017). Global Innovation Systems—A conceptual framework for innovation dynamics in transnational contexts. *Research Policy*, 46(7), 1284-1298.

Hekkert, M. P., Suurs, R. A., Negro, S. O., Kuhlmann, S., & Smits, R. E. (2007). Functions of innovation systems: A new approach for analysing technological change. Technological forecasting and social change, 74(4), 413-432.

Bergek, A., Hekkert, M., & Jacobsson, S. (2008). Functions in innovation systems: A framework for analysing energy system dynamics and identifying goals for system-building activities by entrepreneurs and policy makers. *Innovation for a low carbon economy: economic, institutional and management approaches*, *79*.

B. CREATION OF A NEW TIS IN A FAST FOLLOWER CONTEXT - WIND ENERGY IN PORTUGAL

1. implementing a local wind energy TIS: key events and functions

2. integrating the international dimension

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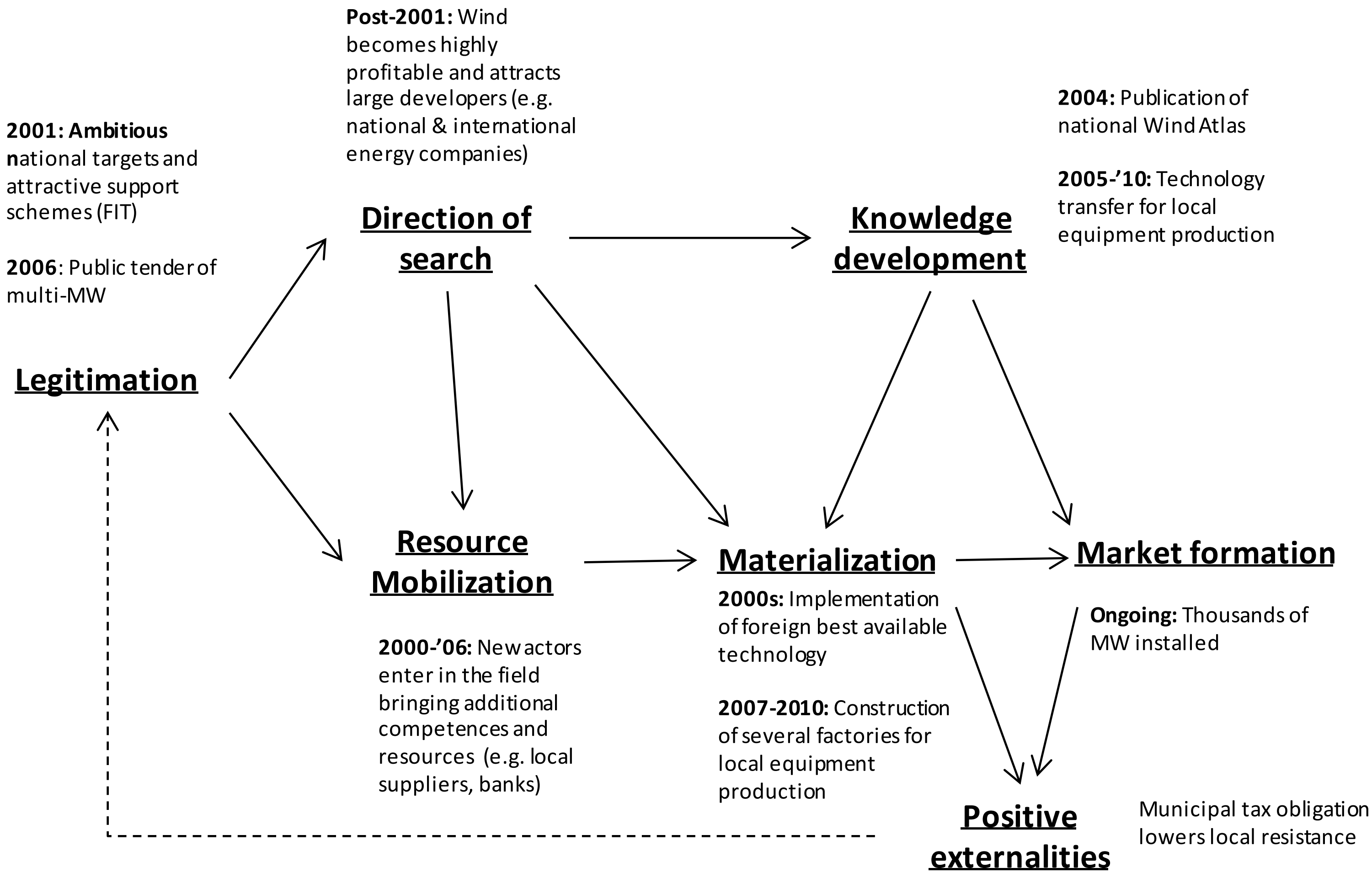


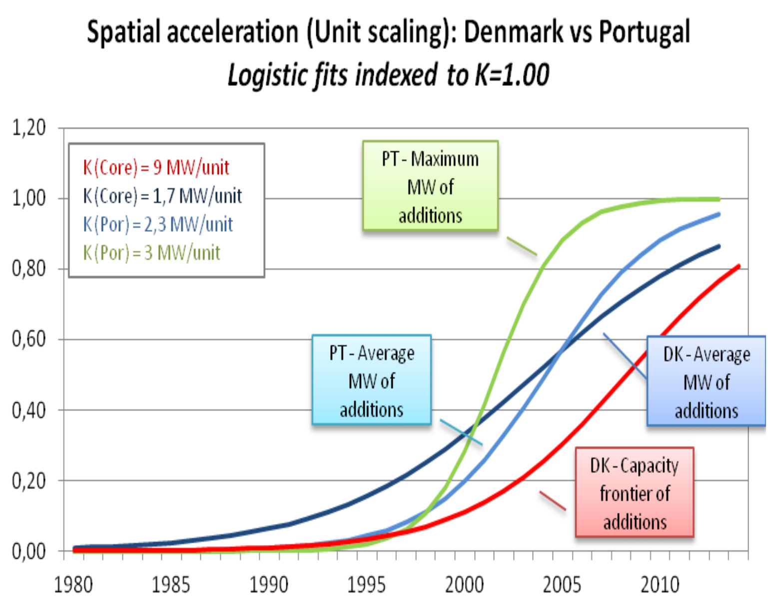
Bento, N., & Fontes, M. (2015). Spatial diffusion and the formation of a technological innovation system in the receiving country: The case of wind energy in Portugal. *Environmental Innovation and Societal Transitions*, 15, 158-179.

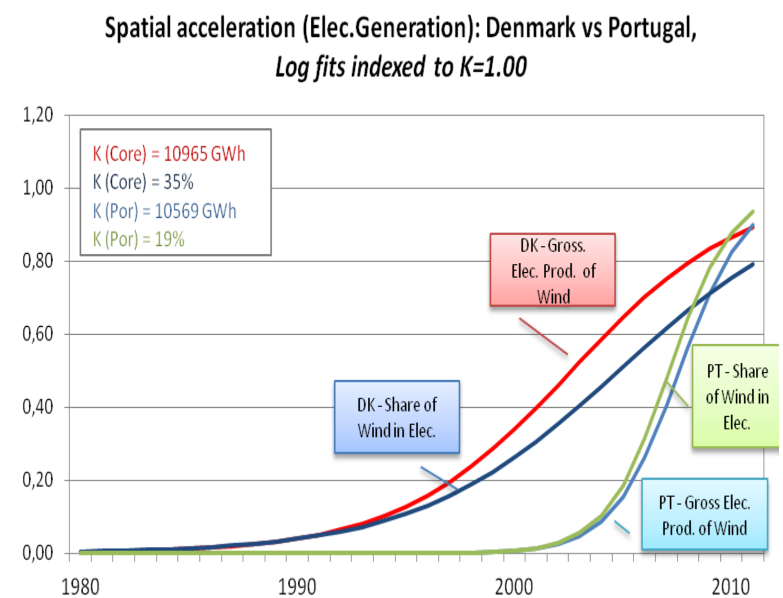
Bento, N., & Fontes, M. (2015). The construction of a new technological innovation system in a follower country: Wind energy in Portugal. *Technological Forecasting and Social Change*, 99, 197-210.

2) Integrating the international dimension

- Knowledge spillovers

Spatial **acceleration** of technology and market **scaling** indicates knowledge spillovers





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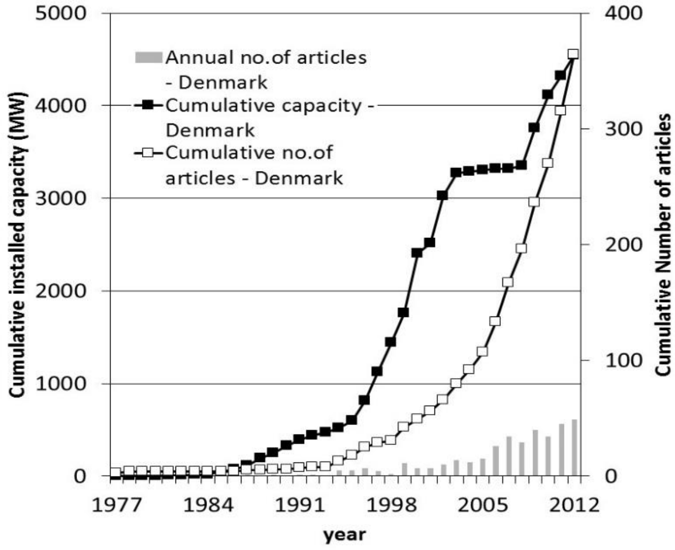
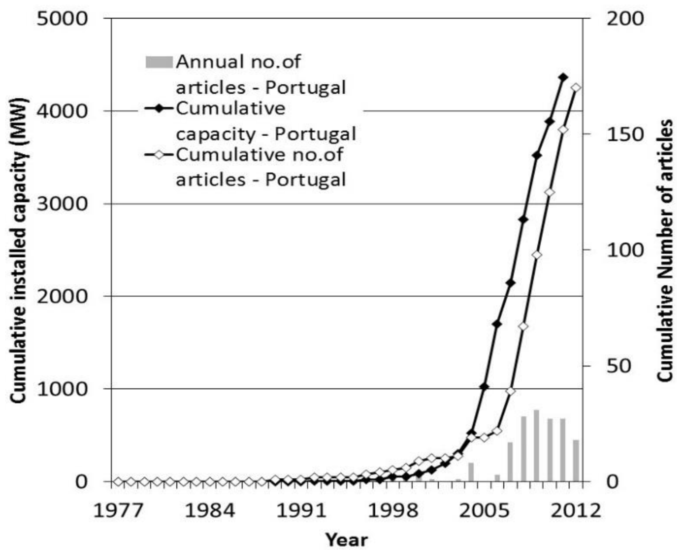
2) Integrating the international dimension

- Knowledge spillovers

- Improved absorptive capacity
  - R&D efforts
  - development of value chain
  - practical knowledge production

Coevolution of knowledge production and diffusion in PT





Sousa C., Bento N., Fontes M. (2014), “Dynamics of knowledge production and technology diffusion: insights from the emergence of wind energy”, Working Papers DINÂMIA'CET, WP n.º 2014/09, ISCTE-IUL.

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- Transnational activities
  - participation in international R&D projects
  - strategic alliances with foreign companies

Contribution of domestic and transnational activities to the fulfillment of the functions of innovation system

Event / FIS	F1. Development of formal knowledge	F2. Entrepreneurial experimentation	F3. Materialization	F4. Influence on the direction of search	F5. Market formation	F6. Resource mobilization	F7. Legitimation	F8. Development of positive externalities
Domestic activities (increasing absorptive capacity)								
- national R&D	•	•		•			•	
- development of local value chain		•	•	•		•	•	•
- support schemes			•	•	•	•	•	•
Transnational activities (capturing knowledge spillovers)								
- international R&D projects	•	•		•				
- strategic alliances with foreign companies		•	•		•	•	•	•

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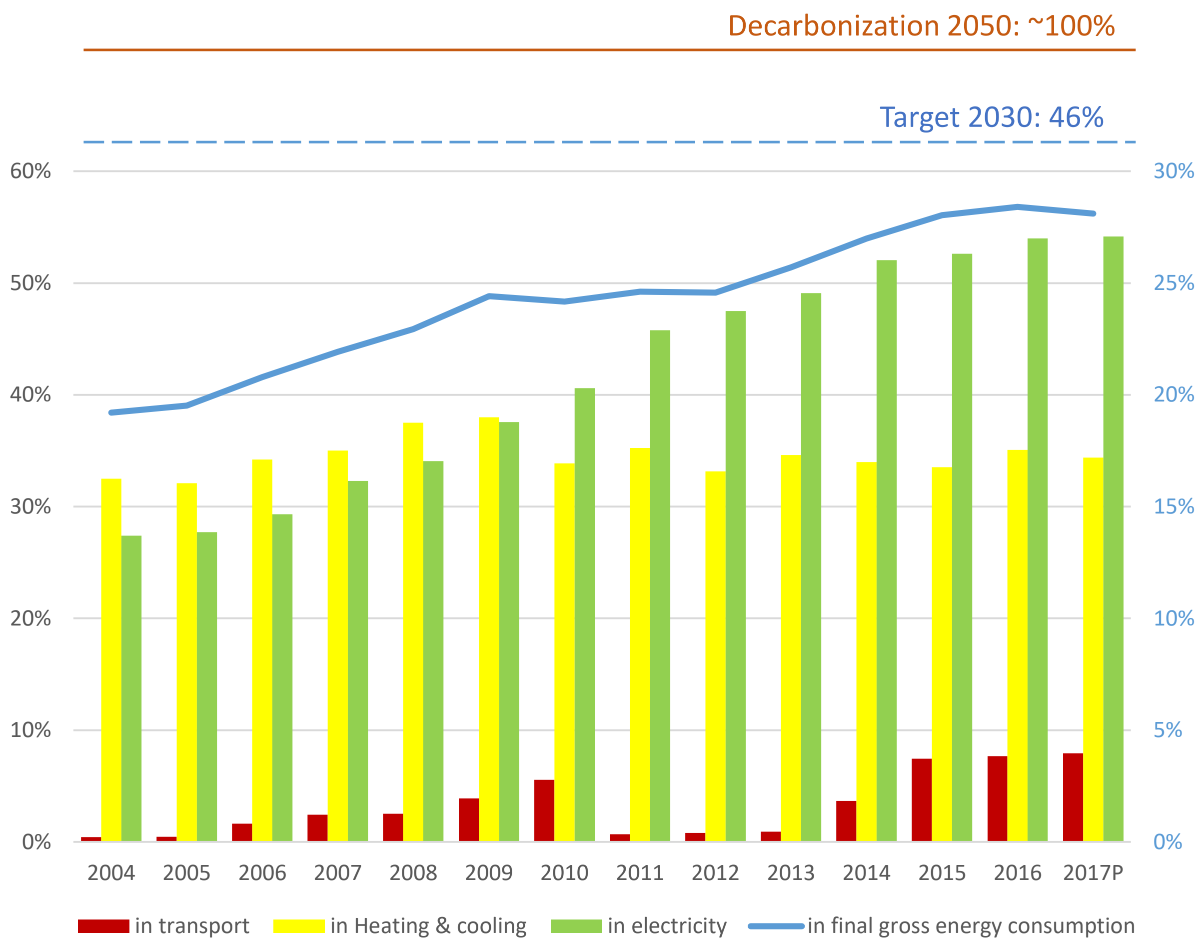
III. Meeting the challenge of decarbonization by 2050

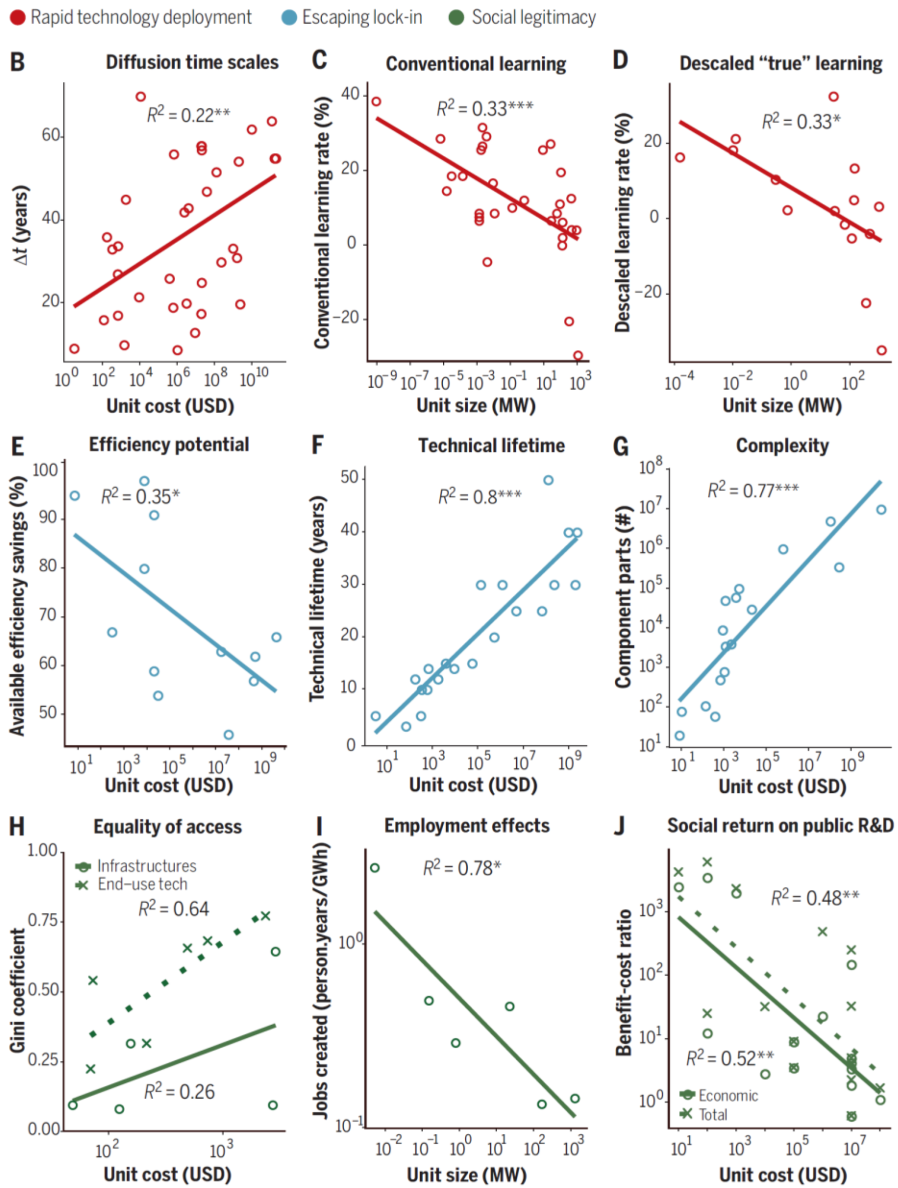
A. Next phase of the energy transition: Spread acceleration

Contribution of RES to gross final energy consumption (in %) in Portugal



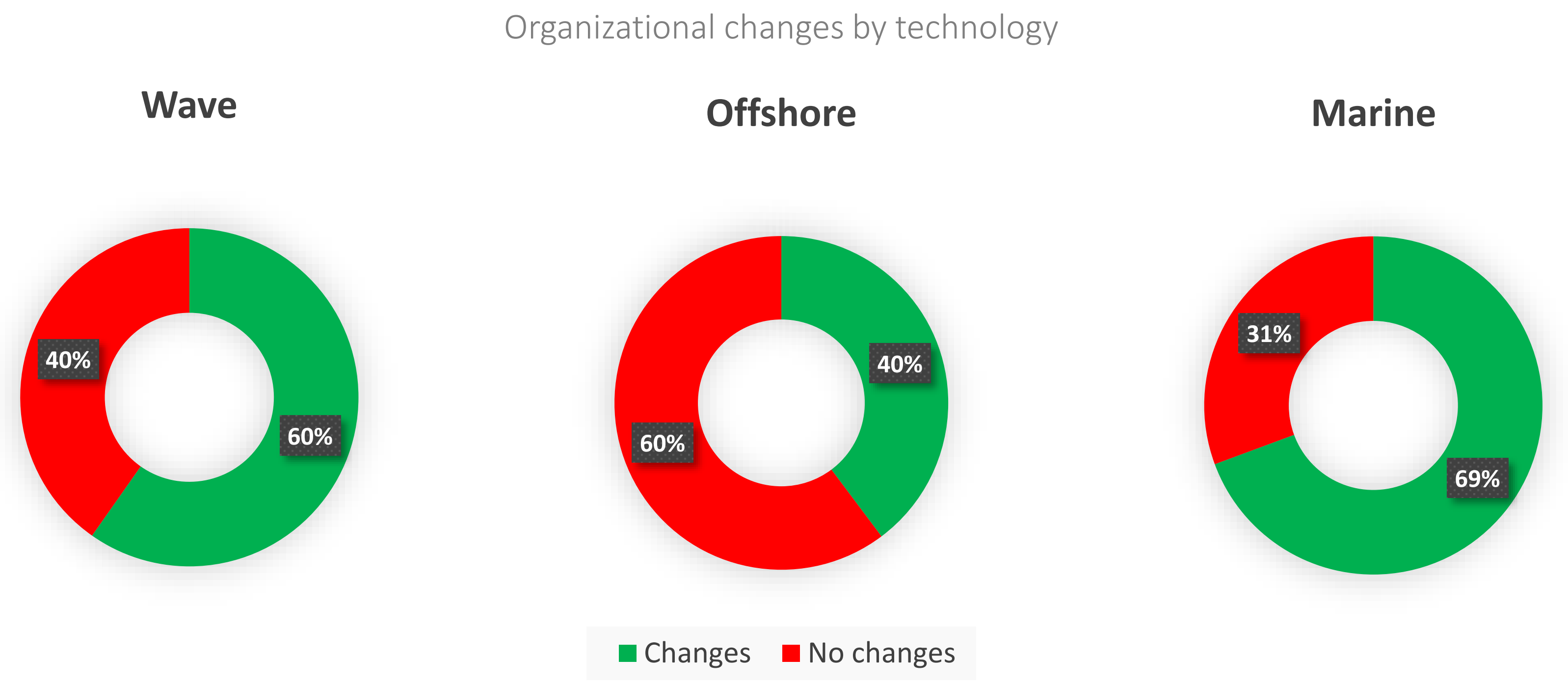
Source: DGEG, 2019.

B. Technological strategies to accelerate decarbonization: granularity



Wilson C., Grubler A., Bento N., Healey S., De Stercke S., Zimm C. (2020), "Granular Energy Technologies for Accelerating Low-Carbon Transformation," *Science* 368 (ISSUE 6486), 3 April 2020.

C. PROMOTE ECONOMIC TRANSFORMATION
e.g. balance speed and impact in Ocean energy technologies



Conclusion

- accelerate diffusion is possible
- monitor knowledge progress and local experiments are key
- non-energy sectors can transform and contribute to transition
- accelerating decarbonization requires rapid dissemination and transformation of activities

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Power2Methane 1st Webinar | 5th June 2020

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