Dii
Renewable energy
bridging continents

The Impact of Transmission Pricing in Network Industries

Dominik Ruderer
Dii GmbH

Gregor Zöttl
University of Munich

Berlin, 10.10.2013

Dii, an international industry network

Dii
Renewable energy
bridging continents

Dii creates in partnership with local authorities and industries a market place in EUMENA for renewable energy (RE) from the deserts

Shareholders

ABB
ABENGOA SOLAR
ACWA POWER
ceVital
DESERTEC FOUNDATION
Deutsche Bank
Enel Green Power
e·on
First Solar
FLAGSOL
HSH NORDBANK
Munich RE
NAREVA Holding
RED ELÉCTRICA DE ESPAÑA
VORWEG GEHEN
SAINT-GOBAIN SOLAR
SCHOTT solar
Terna
TERNA ENERGY SA
UniCredit

Associated Partners

AGC
Audi
BearingPoint
BILFINGER
elecnor
FLABEG
Fraunhofer
ILF
INTESA SANPAOLO
Italgen Italcementi Group
LAHMEYER INTERNATIONAL
LEONI
MAURI SOLAIRE
SMA
Soitec
TÜV SÜD Choose certainty. Add value.

Country specific Dii partnerships with major associations and institutions

Dii
Renewable energy
bridging continents

Country specific cooperation agreements

	Tunisia	Morocco	Algeria	Egypt
Partner	Société Tunisienne de l'Electricité et du Gaz	masen Moroccan Agency for Solar Energy	سونلغاز SONELGAZ	NREA
Date of signature	**April 2011**	**May 2011**	**December 2011**	**January 2013**
Content	▪ Pre-feasibility study for RE projects in Tunisia ▪ Creation of an appropriate legal and regulatory framework ▪ Identification of potential for local industry involvement	▪ Business case identification for solar energy export project in Morocco ▪ Reference Project promotion	▪ Study on all relevant aspects for RE projects in Algeria ▪ Support in RE advancement ▪ Exchange of technical expertise ▪ Promotion of industrial coop	▪ Support of local institutions to disseminate RE projects ▪ Exchange of data e.g. for solar and wind resources analysis, grid expansion, legal frameworks, etc.

Source: Dii

© Dii GmbH
11 October 2013
3

Regional Dii partnerships with major associations and institutions

Dii
Renewable energy bridging continents

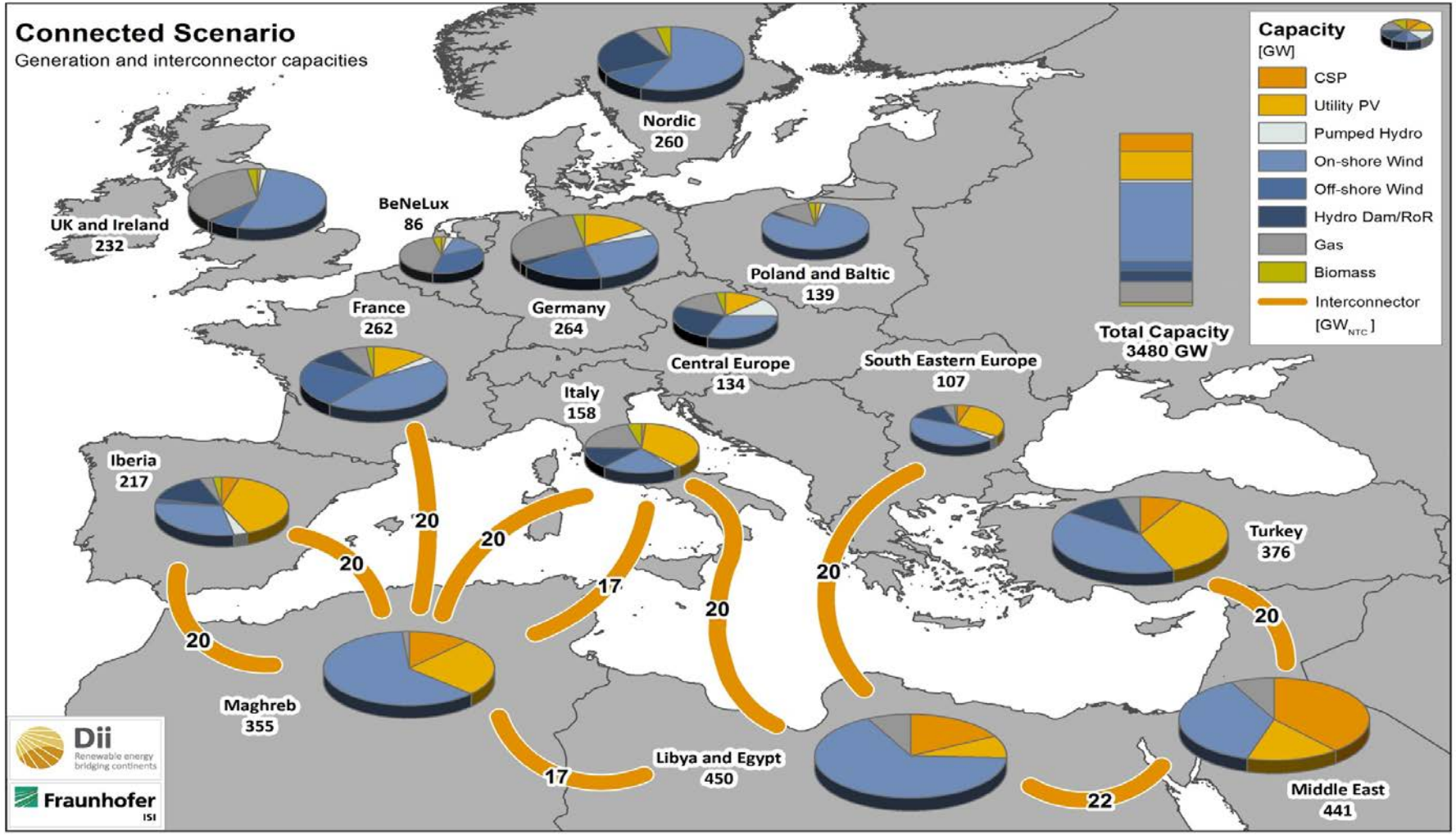
Regional cooperation agreements

Partner	Medgrid	Friends of the Supergrid	UfM	RES4MED	RCREEE
Date of signature	November 2011	March 2012	May 2012	November 2012	April 2013
Content	▪ Coordinated actions in the fields of long term generation, transmission and marketability of renewable energy in Europe and the MENA region	▪ Contribution to the development of regulatory, technical, and supply chain frameworks appropriate for delivering an integrated grid network	▪ Cooperation among others on policy, regulation, assessment of transmission and storage infrastructures, EU-MENA interconnections, financing tools, support schemes	▪ Application of mutual experience and expertise towards the promotion of RE strategies in the Mediterranean ▪ Proposition of plans to encourage investments in the region	▪ Intensified collaboration in a range of activities, with the goal to increase the share of cost-effective renewable energy and energy efficiency policies in the Arab region

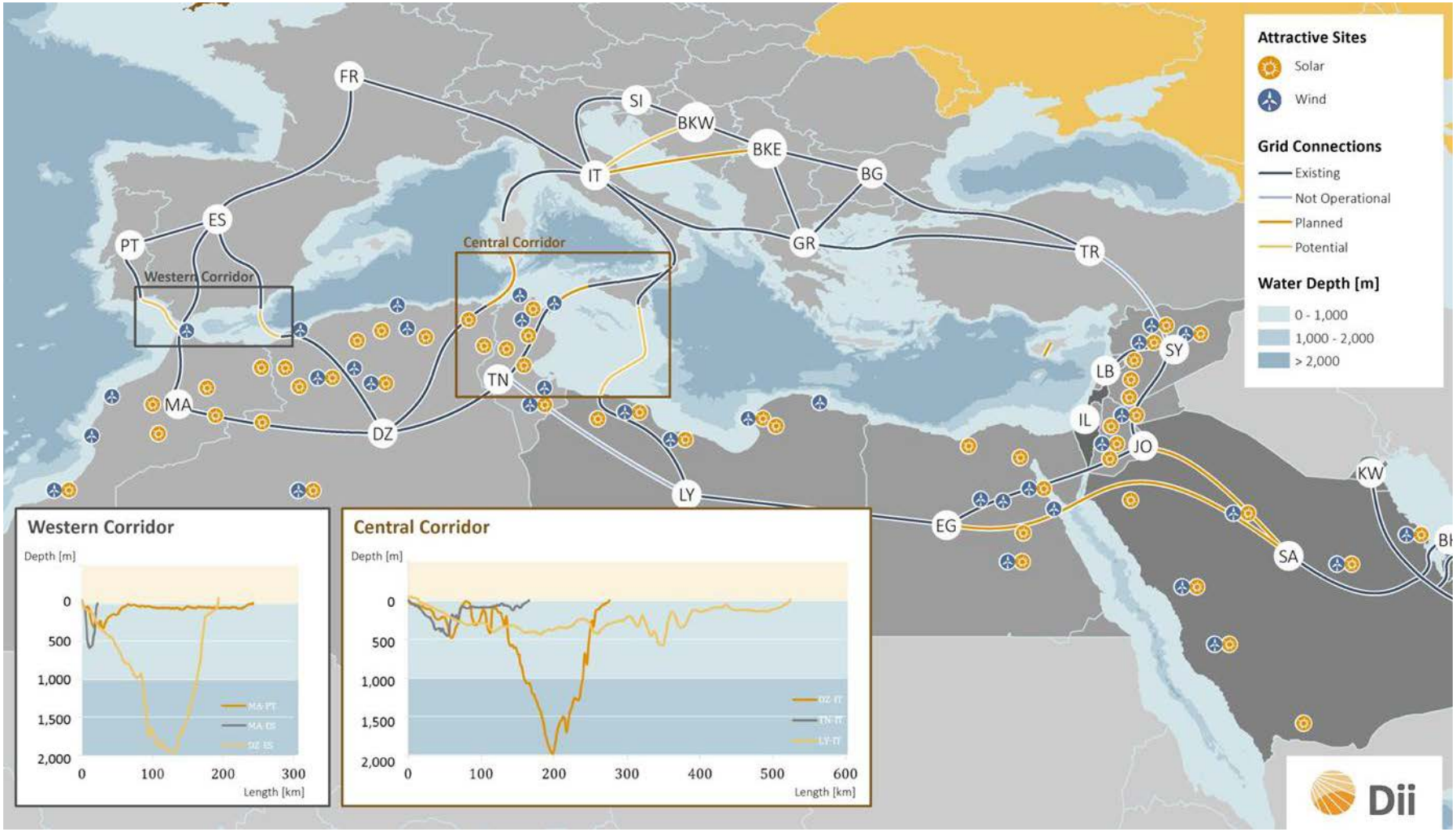
Source: Dii

© Dii GmbH
11 October 2013
4

Dii's Vision: An interconnected EUMENA power market based on renewables. Therefore, …



Dii helps to create transparency, identify concrete investment opportunities and projects …

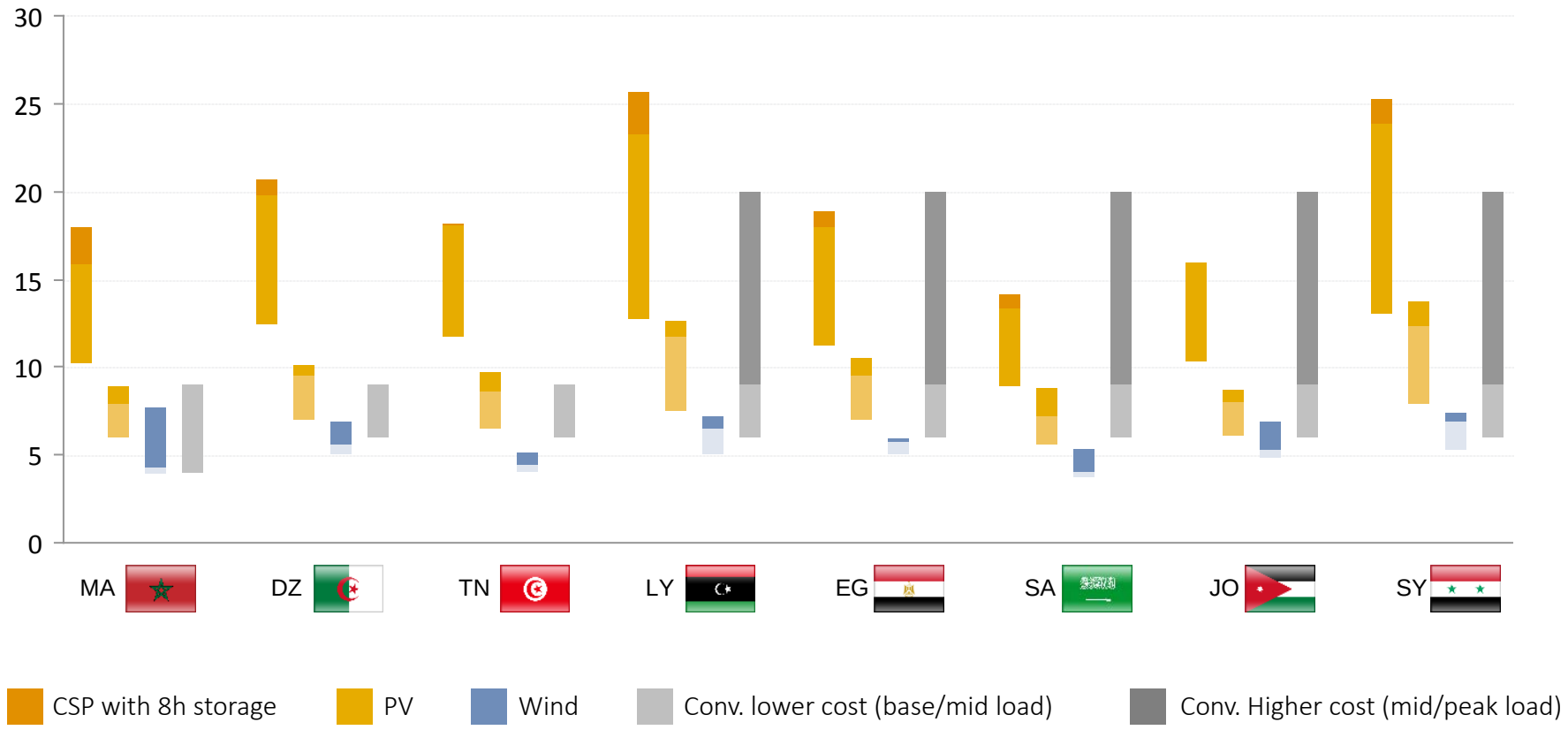


Source: Dii

Several renewable technologies are already commercially viable today in the MENA region

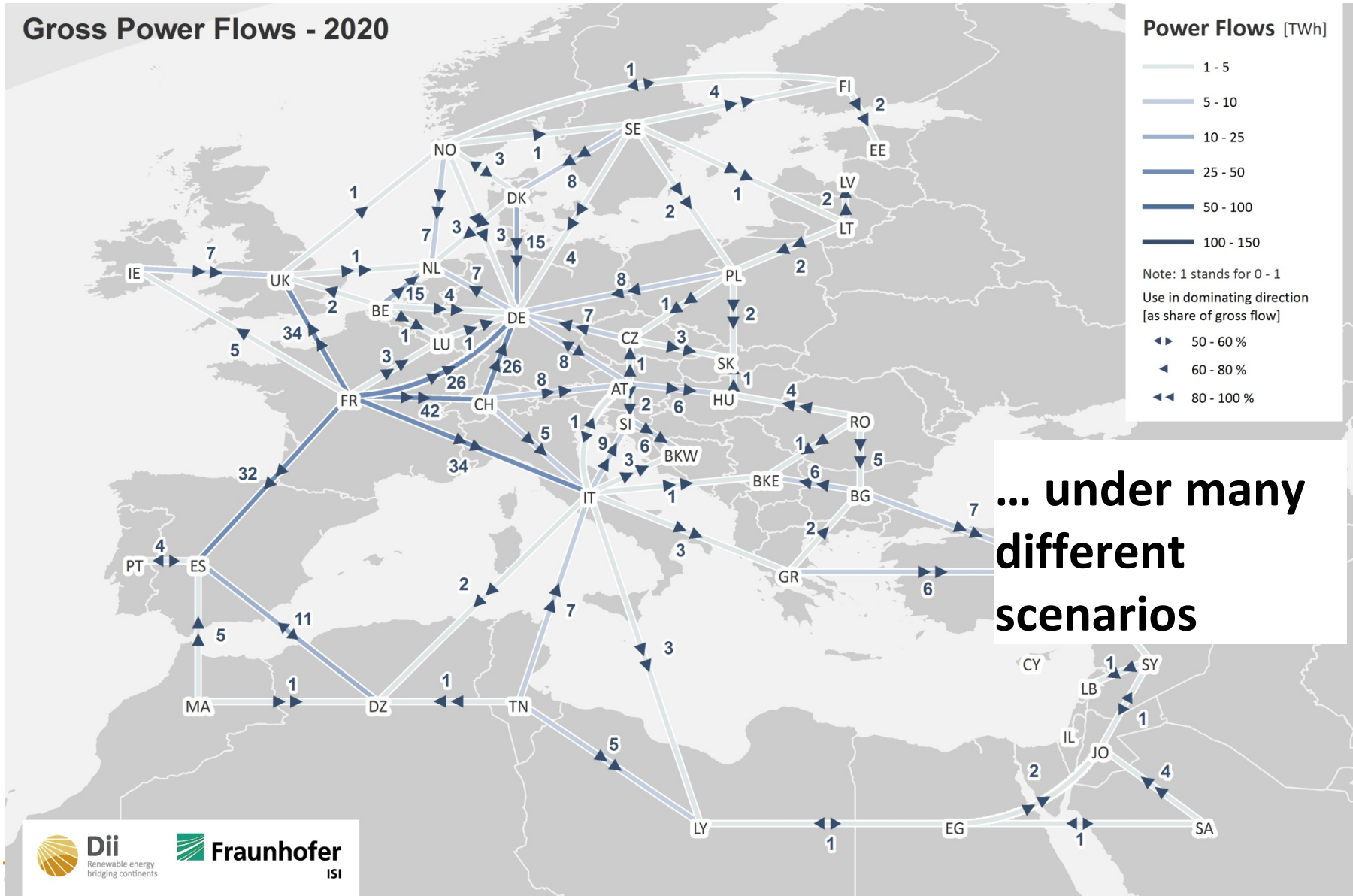
Dii
Renewable energy
bridging continents

Expected cost of RE installations in MENA until 2020 [€ct/kWh]



Source: Dii Note: RE LCOE calculated based on identified sites and country-specific Dii cost of capital estimates
Conventional generation has been estimated with 40€/MWh for Coal, 60€/MWh for CCGT, 90€/MWh OCGT for and up to 200€/MWh for oil-fired power plants.

Cross-Med interconnectors are among the most attractive, besides those in the North Sea …



… advice on policy making and regulation, strategy and providing networking opportunities

Dii
Renewable energy
bridging continents

Input in political processes: broadly appreciated in-depth analysis and insights on

- Renewables in MENA
- Mediterranean/MENA grid & market integration

Better policy making: public consultations, general advice on

- Power sector & transmission regulation
- Grid, system & market design/optimization
- RE support schemes & RE financing

Networking platform: exchange on desert power, especially

- Between MENA and Europe
- Between industry & public actors & civil society
- Covering all RE technologies, and whole value chain

Public awareness: public attention for & positive news about RE and about MENA

LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

Dii Renewable energy bridging continents

The Impact of Transmission Pricing in Network Industries

Dominik Ruderer
Dii GmbH

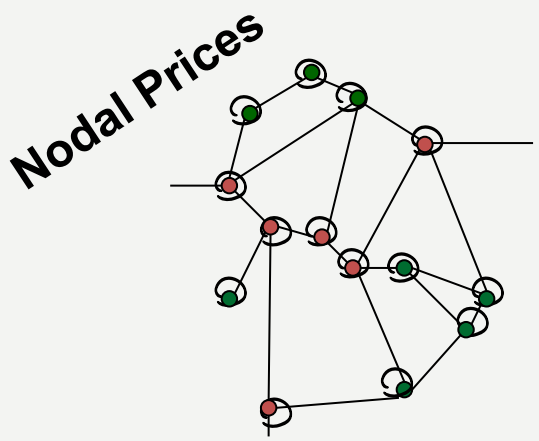
Gregor Zöttl
University of Munich

Berlin, 10.10.2013

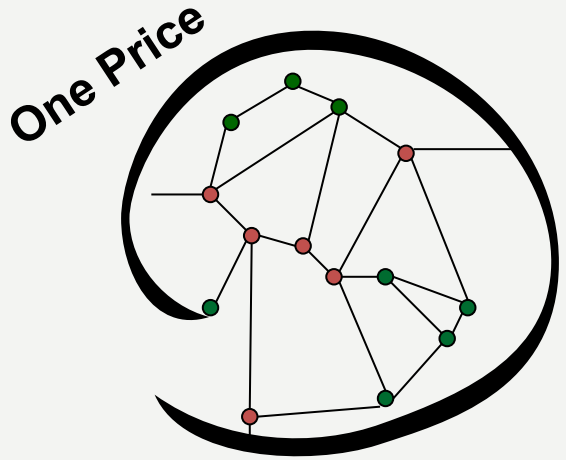
Introduction

- Capacity adequacy is in the focus of debate in liberalized electricity markets → Market design is decisive
- We compare the **long run effects** (on gen. & trans. capacity) of two different market design variants used to accommodate scarce transmission capacities

Locational Marginal Pricing / Nodal Pricing (e.g. PJM, CAISO)



Uniform Pricing (Redispatch System) (e.g. DE, FR, GB)



Question: How do the different market design variants affect

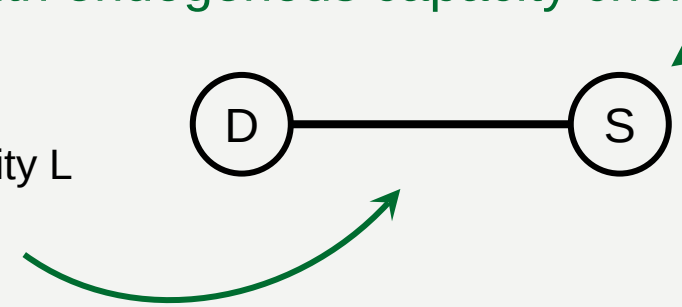
- investment in generation facilities?
- the generation technology mix (base- vs. peakload)?
- investment in transmission facilities?

Preview on Results

- Short run
  - Both market design variants deliver an efficient dispatch
  - Uniform pricing results in a higher payoff for generators
- Long run consequences of uniform pricing
  - **Generators inefficiently overinvest**
  - Generation overinvestment requires **more transmission investment**
  - Uniform pricing leads to a **distortion of the generation technology mix**
  - Adjusting transmission pricing can correct for distortions (e.g. UK)

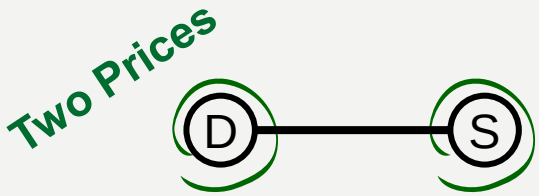
Network model with endogenous capacity choice

1 Planner chooses transmission capacity L optimally

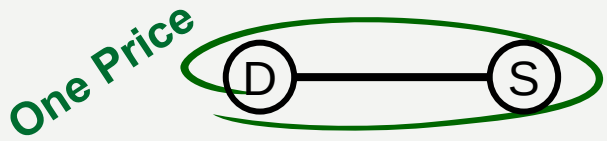


2 Choice of generation capacity X and technology mix by competitive investors

3 Two market design variants at the spot market



→ Transmission constraints are priced at the spot market

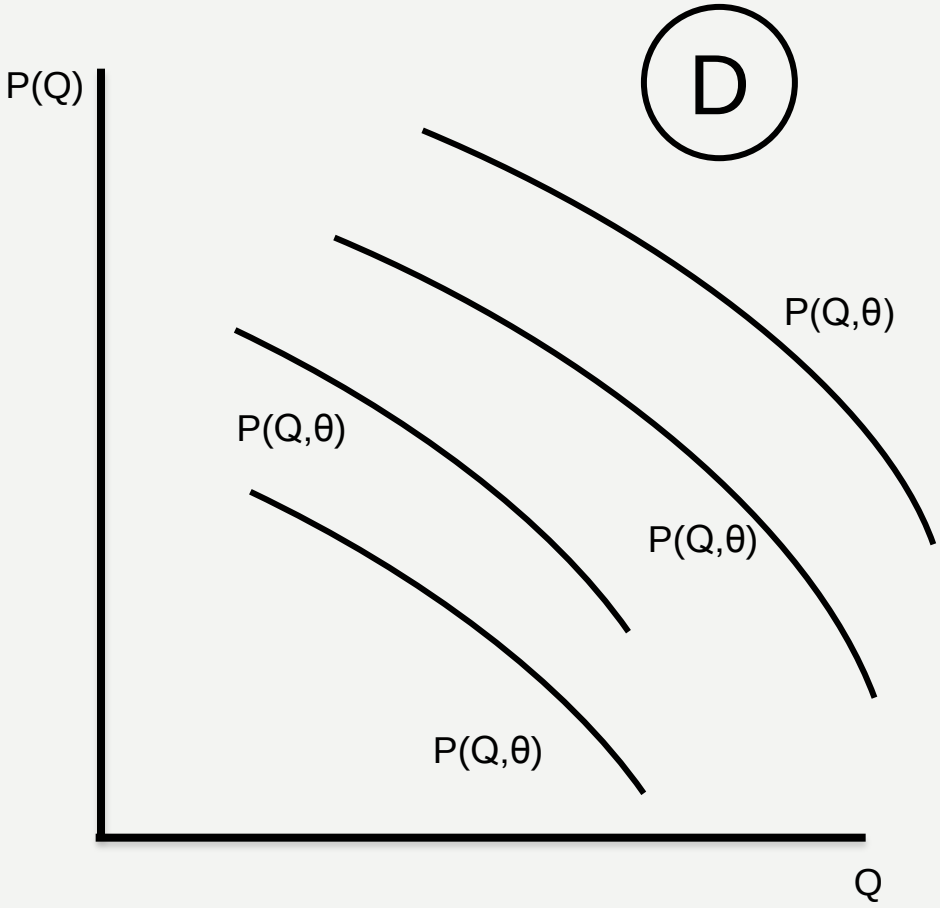


→ Transmission constraints are not reflected at the spot market

→ Potentially, redispatch to be performed

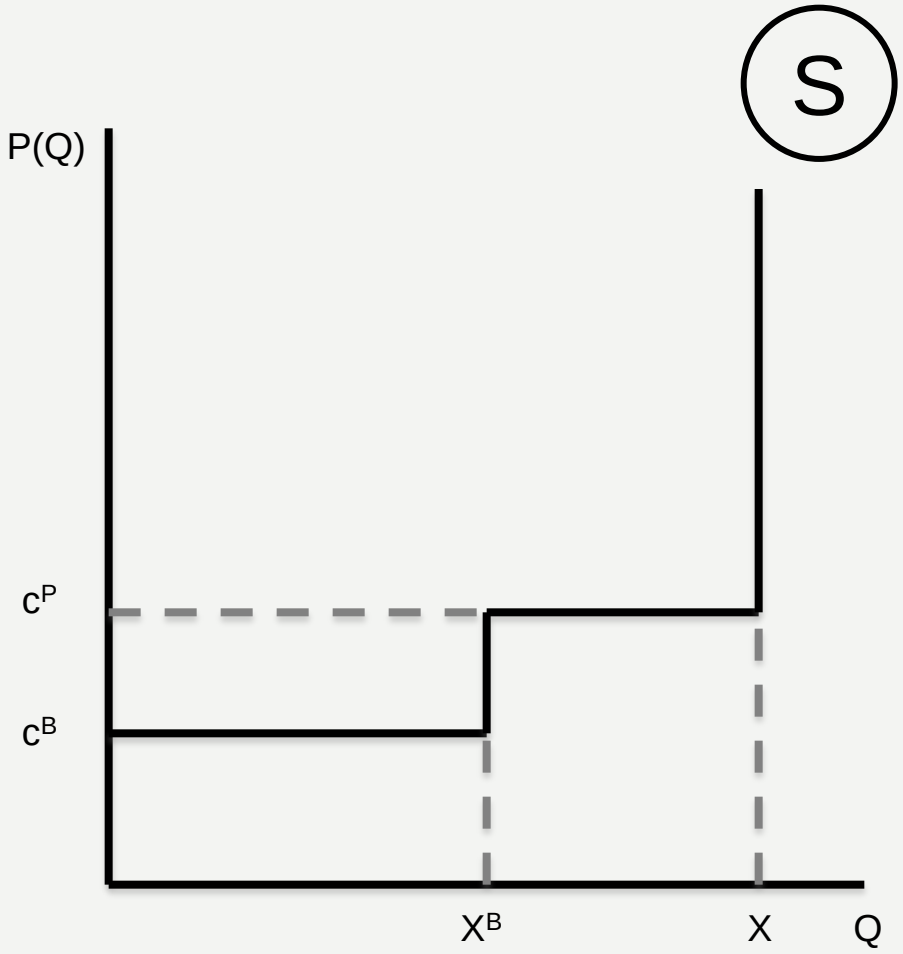
Demand Node

- Inverse demand $P(Q,\theta)$, with $P_q(Q,\theta)<0$
- θ captures the different levels of demand
  - Frequency $f(\theta)$
  - Support $[\underline{\theta}, \bar{\theta}]$
  - Distribution $F(\theta)$



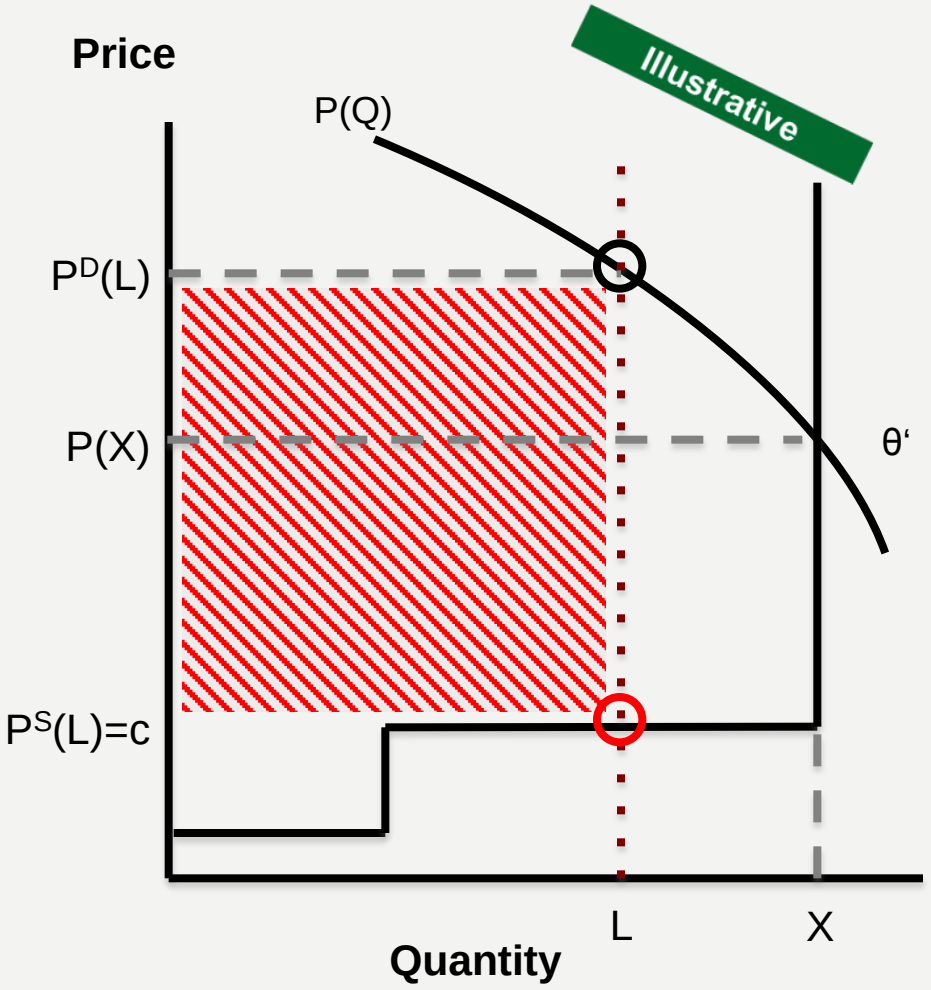
Supply Node

- *competitive firms*
- firms can invest in 2 different technologies, B and P
- Assumptions:
  - cost of investment $k^B > k^P$
  - cost of production $c^B < c^P$
  - e.g.: nuclear-, lignite-, coal-, and gas-fired power plants



Nodal Pricing

Spot Market

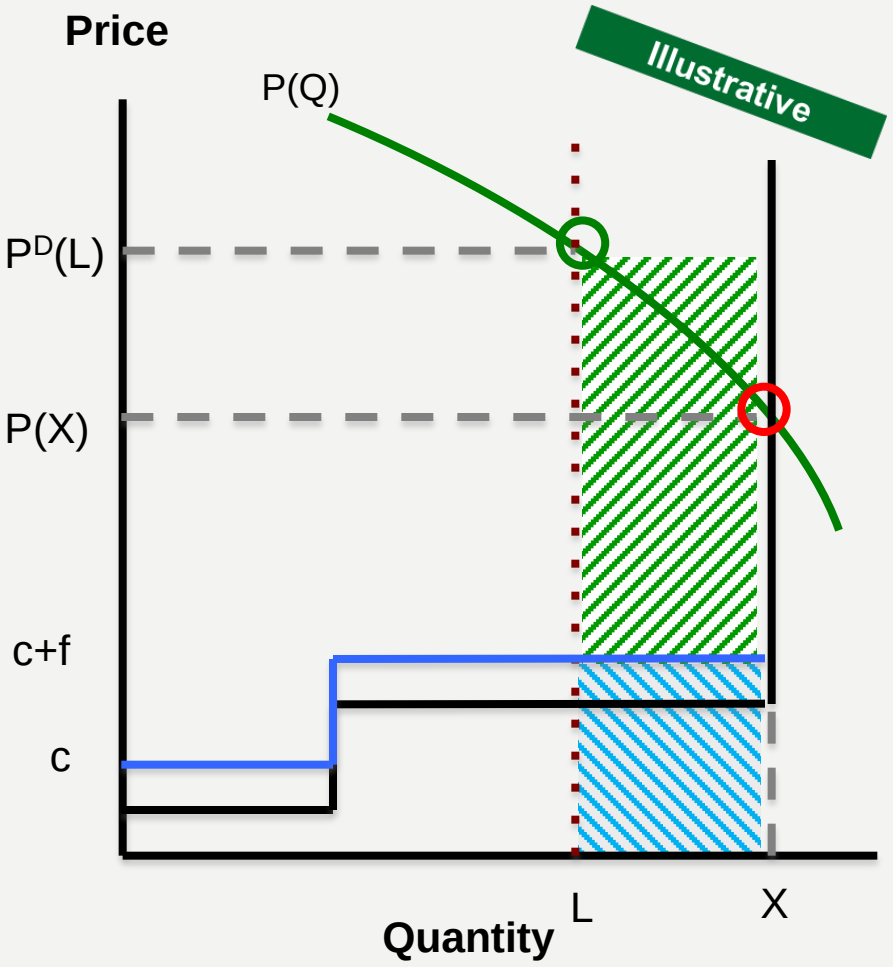


- At given spot market, both sides would like to trade quantity X at price $P(X)$
- Line capacity only quantity L

  → Prices $P^D(L)$ and $P^S(L)=c$ clear the market
- Nodal prices lead to an efficient spot market allocation and allow to efficiently price investment
- Financing of transmission network (the link L) takes place by differences in nodal prices.

Uniform Pricing

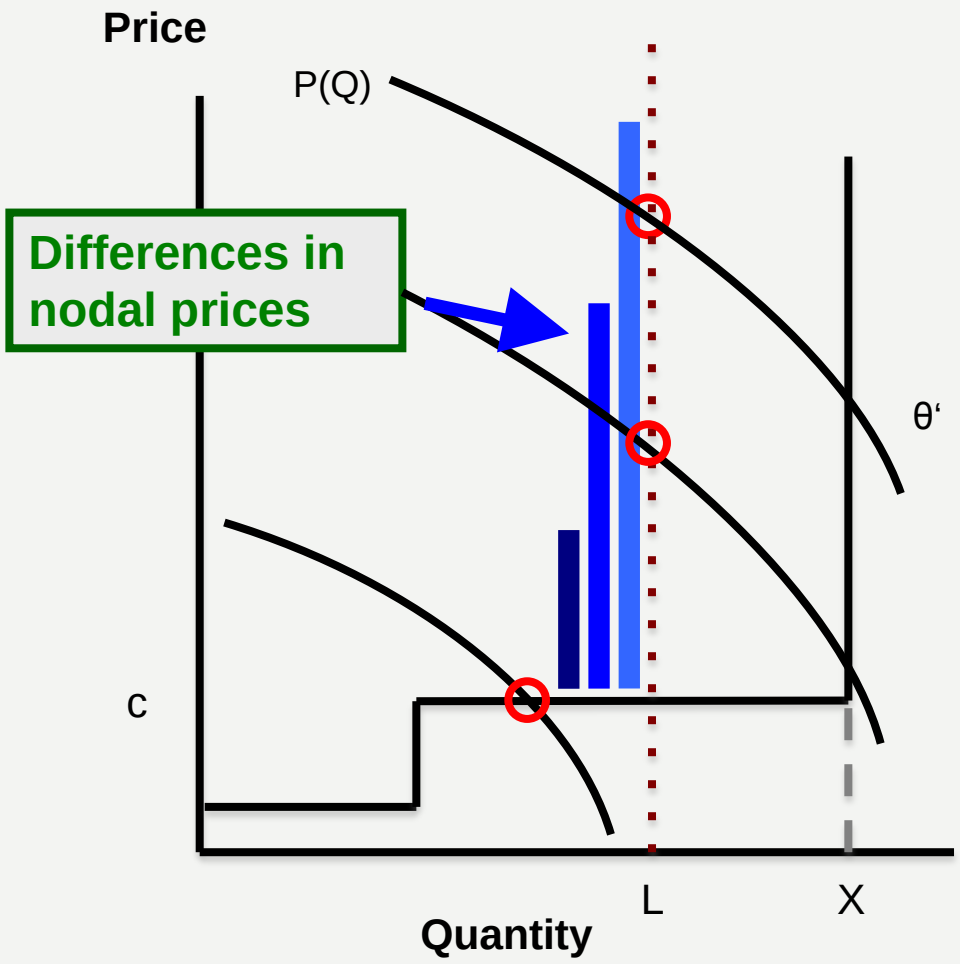
Spot Market



- At given spot market, both sides trade quantity X at price $P(X)$.
- But: Market cannot be cleared (since $L<X$!). To clear market **redispatch** is needed:
  - Operator buys at the demand node and sells at the supply node.
  - Price at redispatch market is $P^D(L)$, some generators pay $c+f$ and do not produce.

    → Financing of the redispatch market and of transmission investment takes place via transmission fee f („Netzentgeld“ in Germany)

Nodal pricing



- Choosing total Investment X

  Whenever X is strictly larger than the transmission link generating firms always loose money!

- Choosing optimal line size L

  For the planner it is never optimal to choose L>X

- Equilibrium:

  Line L and total capacity X are chosen identically (L=X)

  The optimal industry configuration (first best) is implemented.

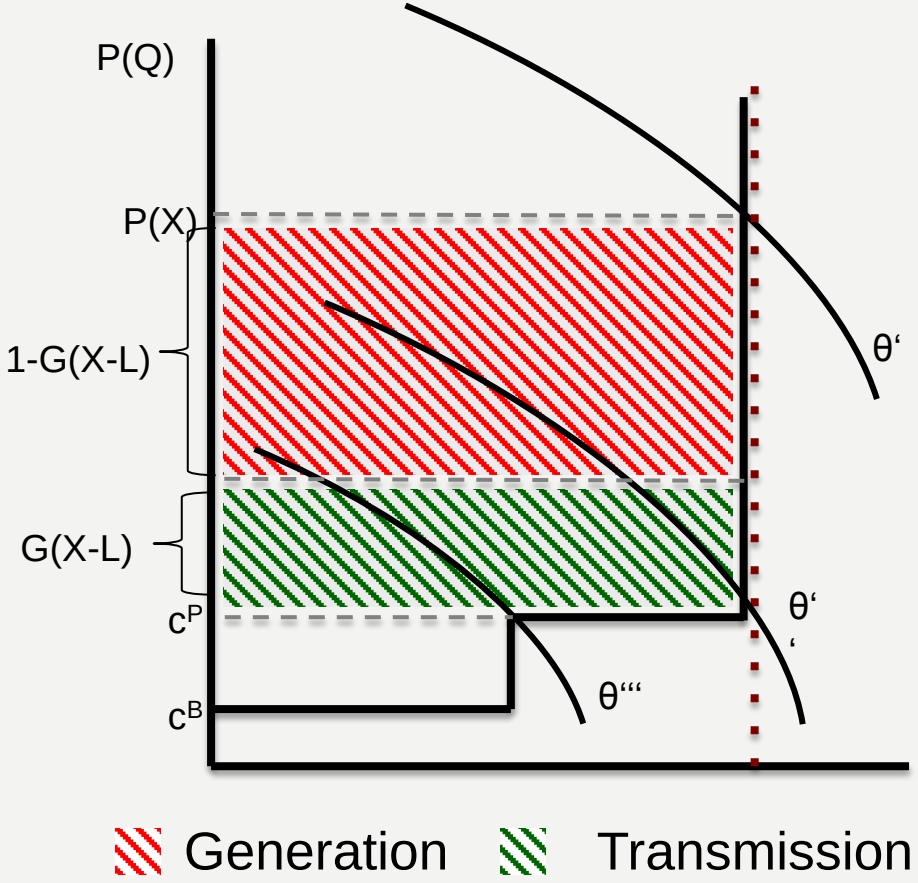
Main Result Nodal Pricing

For the case of nodal pricing we establish:

- Investment in baseload and peakload generation facilities
- Investment in the Transmission line

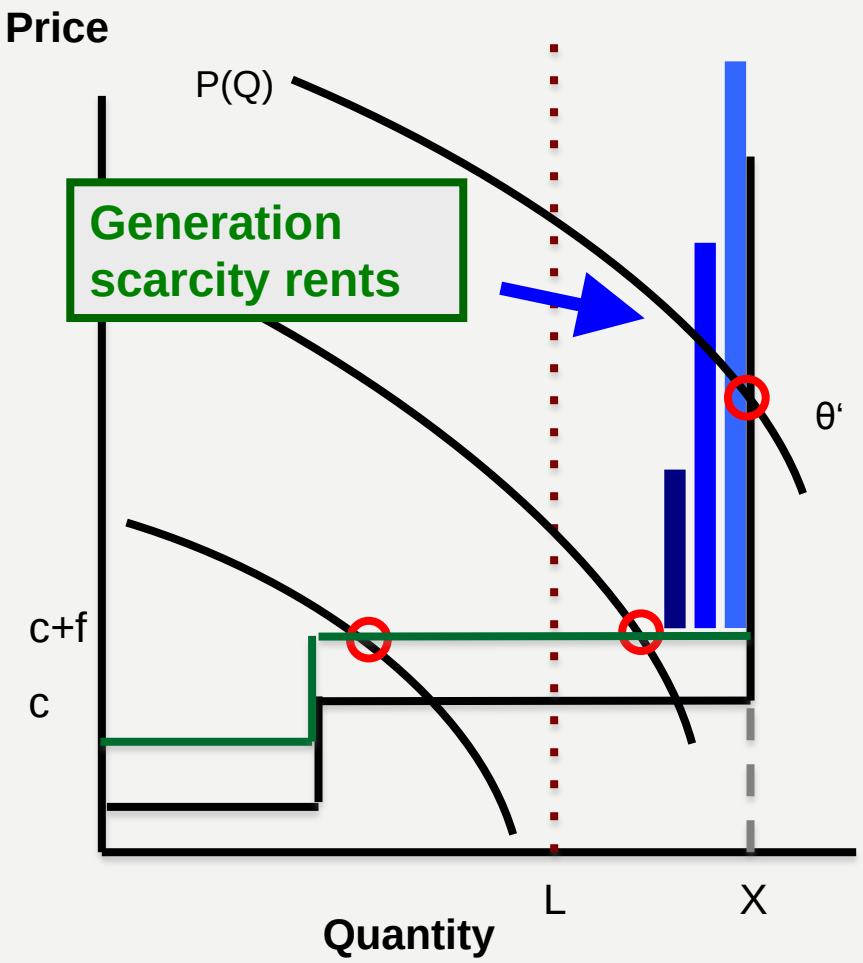
As we show this implements the optimal market solution (first best).

Allocation of scarcity rents



Uniform Pricing

Investment



- Choosing Total Investment X

  The rents earned on the spot market are independent of the size of line L.

- Choosing optimal line size L

  For the planner it is typically optimal to choose the line equal to total investment X.

- Equilibrium

  Line L and total capacity X are chosen identically, both are larger than in the nodal pricing scenario, as we show!

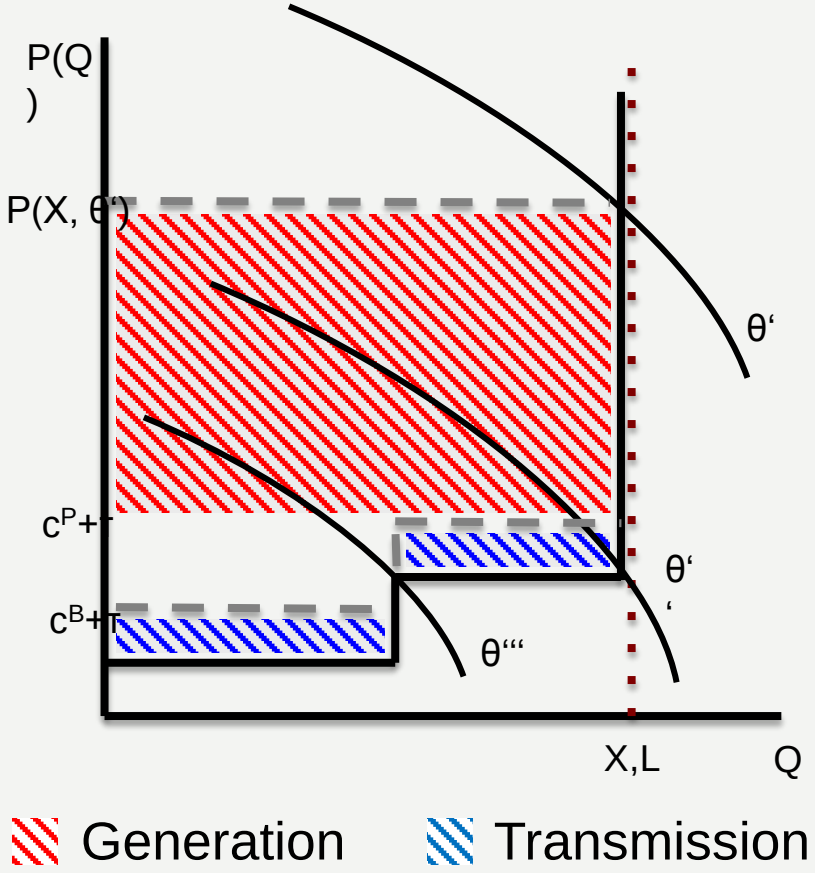
Main Result Uniform Pricing

Total investment in generation facilities and investment in the transmission line is strictly larger than under nodal pricing (and first best).

Redispatch system distorts the technology mix:

- more investment in peakload technology – earns money at the margin
- less baseload technology – earns money inframarginally

Allocation of scarcity rents



Intuition

- A system with uniform pricing leads to overinvestment in total capacity as it shifts the financing of the network from the marginal units (where the money is) to the infra-marginal units (where no money is).
- No investor makes profits in expectation
- Market is always independently financed (differences in nodal prices and network fees respectively)
- But: consumers pay for this extra capacity (higher infra-marginal prices!)
- Capacity based transmission fees (instead of energy based) can help to ease the problem (Ex. UK)

Summary

- Framework: Planner chooses transmission line investment and competitive firms choose to invest in generation capacity
- Illustration of results in a two node network (also obtain for more complex networks)
- **Result**:
  - Total investment in generation as well as in transmission is larger in the redispatch regime than in the nodal pricing regime (+ distortion towards base technologies).
  - Put differently: Our results suggest that overall investment should decrease when switching from a redispatch system to a system of nodal pricing!
- Remark: Results do not imply that nodal pricing is bad, they just show that generation investment is larger under redispatch!

Thank you for the attentions

Dii
Renewable energy
bridging continents

Workshop on **Long-term transmission rights**

26.11. in Brussels

hosted by the Energy Charter Secreteriat

4th Dii DESERT ENERGY CONFERENCE RABAT|2013

30th – 31st October 2013

Dii