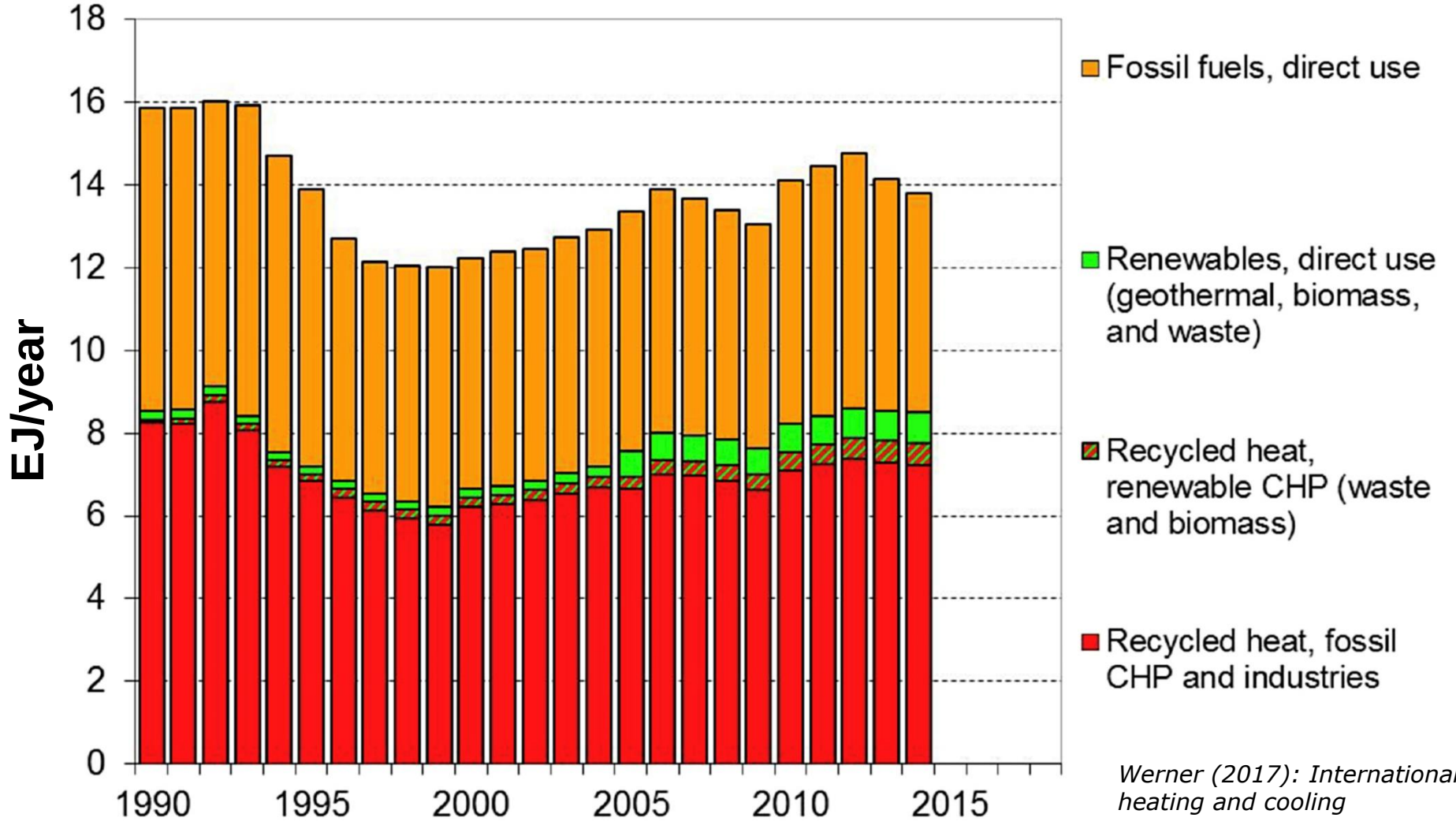

DTU

Daniel Møller Sneum – SES Conference 2020

Flexibility in the interface between district energy and the electricity system

1. CONTEXT

HEAT SUPPLIED INTO DISTRICT HEATING GLOBALLY



Werner (2017): International review of district heating and cooling

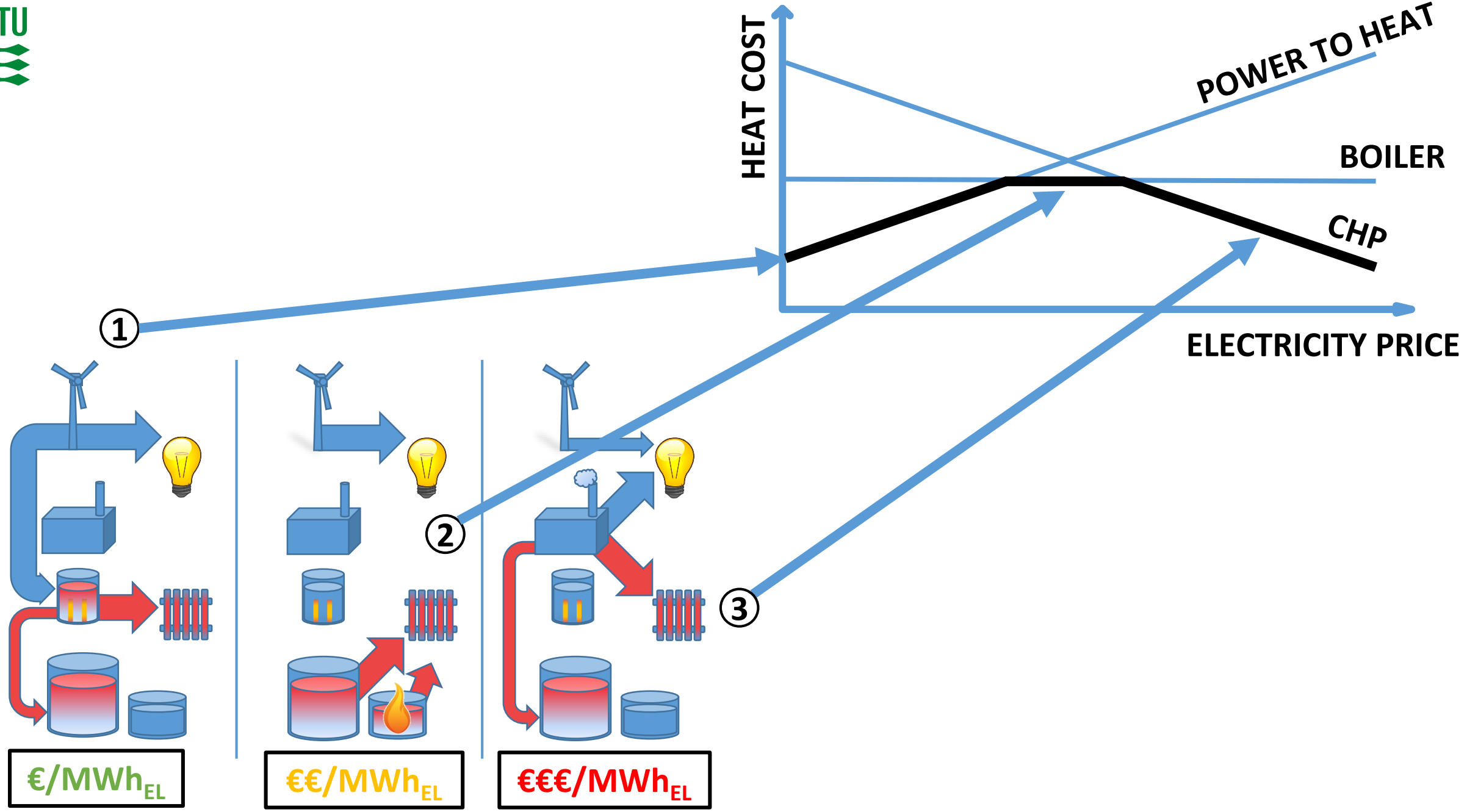
Research question

2. MOTIVATION

Which framework conditions hinder flexible operation in the district energy-electricity system interface, and what are their consequences?

Flexible district energy

3. CONCEPTS


HEAT COST
POWER TO HEAT
BOILER
CHP
ELECTRICITY PRICE
1
2
3
€/MWh$_{EL}$
€€/MWh$_{EL}$
€€€/MWh$_{EL}$

A – TAXONOMY

B – CAMPUS SYSTEMS

F – FUEL SUBSTITUTION

4. RESULTS

A – TAXONOMY

If you want to study barriers to

- Smart energy systems

- Sector coupling

- Flexibility of district energy systems

TAXONOMY FOR BARRIERS TO FLEXIBILITY IN THE DE-ELECTRICITY SYSTEM INTERFACE

Category	Sub-category	Barrier name	#
Operational signalling	Dispatch signals	Absence of signal-providing scheme	1
-	-	Electricity market: Absence of flexibility-need (involatile prices)	2
-	-	Electricity market: Fixed electricity prices	3
-	-	Physical vs. financial dispatch: Must-run operation	4
-	Operational taxes and subsidies	Operational taxes on flexible DE	5
-	-	Favourable operational taxes on NEITG	6
-	-	Inflexible operational subsidies for flexible DE	7
-	-	Operational subsidies for NEITG	8
-	Electricity grid tariffs	Electricity grid tariffs	9
	Signal-related		

TAXONOMY FOR BARRIERS TO FLEXIBILITY IN THE DE-ELECTRICITY SYSTEM INTERFACE

Category	Sub-category	Barrier name	#
Investment	-	Investment subsidies for NEITG	12
-	-	Limitations in capital for flexible DE	13
-	-	High risk premium for financing flexible DE	14
-	-	Internal limitations from pay-back time and internal rate of return/discount rate requirements	15
-	-	Externally imposed limitations from regulated rate of return	16
Permitting	-	Technology bans and mandates	17
-	-	Inadequate legal framework for evaluation of DE projects	18
-	-	Friction in the permitting process	19
Ownership	-	Tax- and ownership regulation disincentivising grid integration	20
DE technology	-		

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DE technology conditions	-	Limitations in adjustability, ramping and lead time	21
-	-	High technological cost	22
-	-	High business process costs	23
-	-	Low supply chain maturity	24
-	-	Limitations in control and visibility	25
-	-	High-temperature systems	26
Grid access	-	High grid-connection cost	27
-	-	Limiting grid codes	28

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-	-	Limiting grid capacity	29
Physical environment	-	Limited access to energy sources	30
		Land availability	31

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	-	Limitations from community bounded rationality	33
	-	Limitations from authority bounded rationality	34
-	-	Limitations from individual plant staff's bounded rationality	35
Acceptance	-	Limitations from organisational acceptance	36
-	-	Limitations from community acceptance	37
			38

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Acceptance	-	Limitations from organisational acceptance	36
-	-	Limitations from community acceptance	37
-	-	Limitations from authority acceptance	38
-	-	Limitations from incumbent acceptance	39
-	-	Limitations from individual plant staff's acceptance	40

TAXONOMY FOR BARRIERS TO FLEXIBILITY IN THE DE-ELECTRICITY SYSTEM INTERFACE

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TAXONOMY FOR BARRIERS TO FLEXIBILITY IN THE DE-ELECTRICITY SYSTEM INTERFACE

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TAXONOMY IN SUMMARY

9 categories; 40 barriers to flexible district energy

Primary barrier founded in the definition of flexibility:

practical ability to

simultaneously respond to

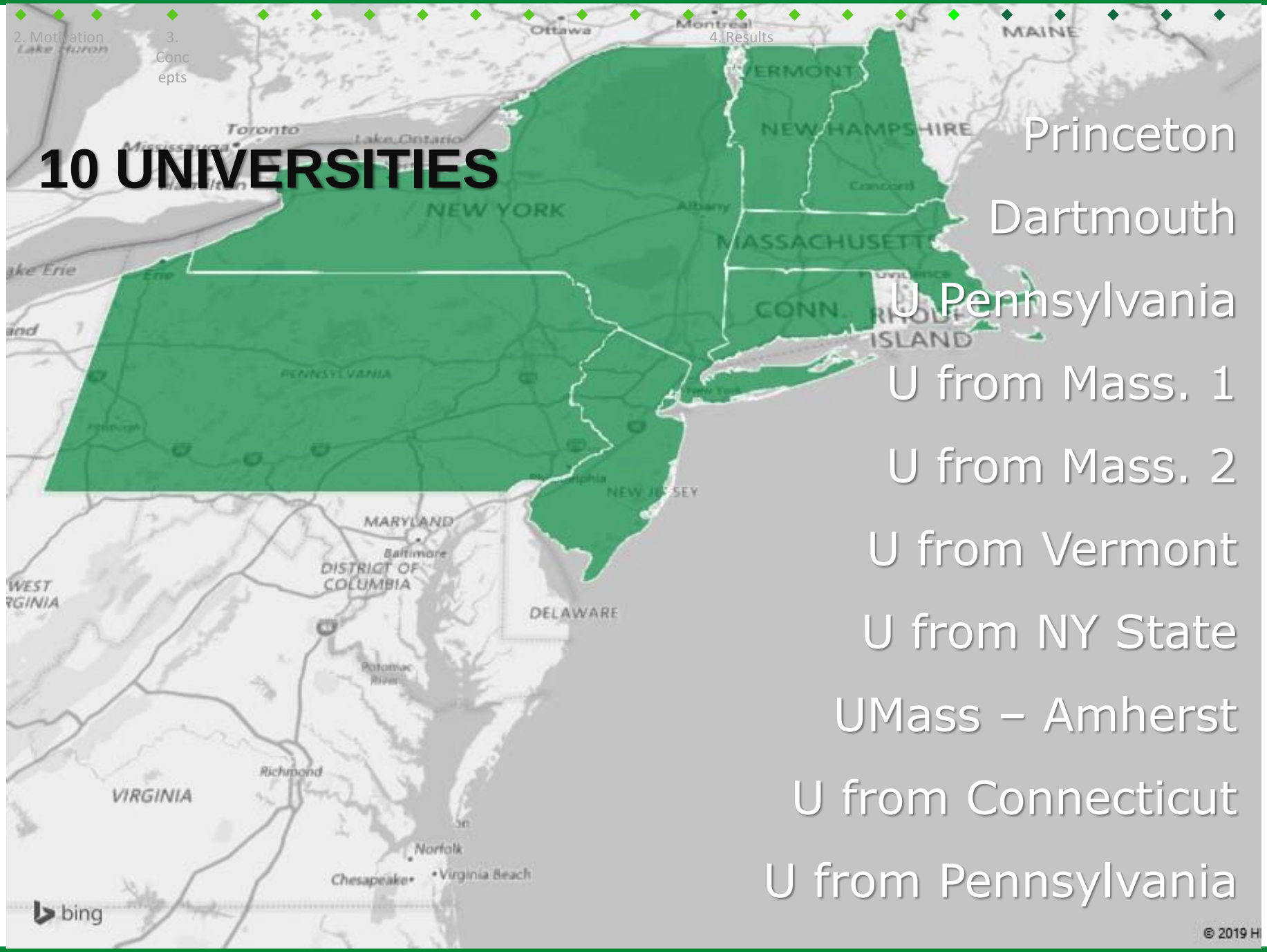
at least hourly varying signals

#1 Absence of signal-providing scheme

B – CAMPUS SYSTEMS

TITLE:

Flexibility of U.S. campus district energy systems in the electricity grid


10 UNIVERSITIES
Princeton
Dartmouth
U Pennsylvania
U from Mass. 1
U from Mass. 2
U from Vermont
U from NY State
UMass – Amherst
U from Connecticut
U from Pennsylvania
Toronto
Ottawa
Montreal
MAINE
VERMONT
NEW HAMPSHIRE
NEW YORK
Albany
Concord
MASSACHUSETTS
CONN.
RHODE ISLAND
PENNSYLVANIA
NEW JERSEY
MARYLAND
Baltimore
DISTRICT OF COLUMBIA
DELAWARE
Potomac River
Richmond
VIRGINIA
Norfolk
Chesapeake
Virginia Beach
bing

5. Technology conditions

Barrier name
Limitations in adjustability, ramping and lead time
High technological cost
High business process costs
Low supply chain maturity
Limitations in control and visibility
High-temperature systems

CAMPUS SYSTEMS IN SUMMARY

18 of 40 barriers identified

Large spread: Advanced automatized – simple manual

Grid tariffs/standby charges potential disincentive for PtH/C

Enough money, just not for hot water conversion

Well-informed and well-funded enough to go green?

Operational signalling

Investment

Permitting

Ownership

DE technology conditions

Grid access

Physical environment

Bounded rationality

Acceptance

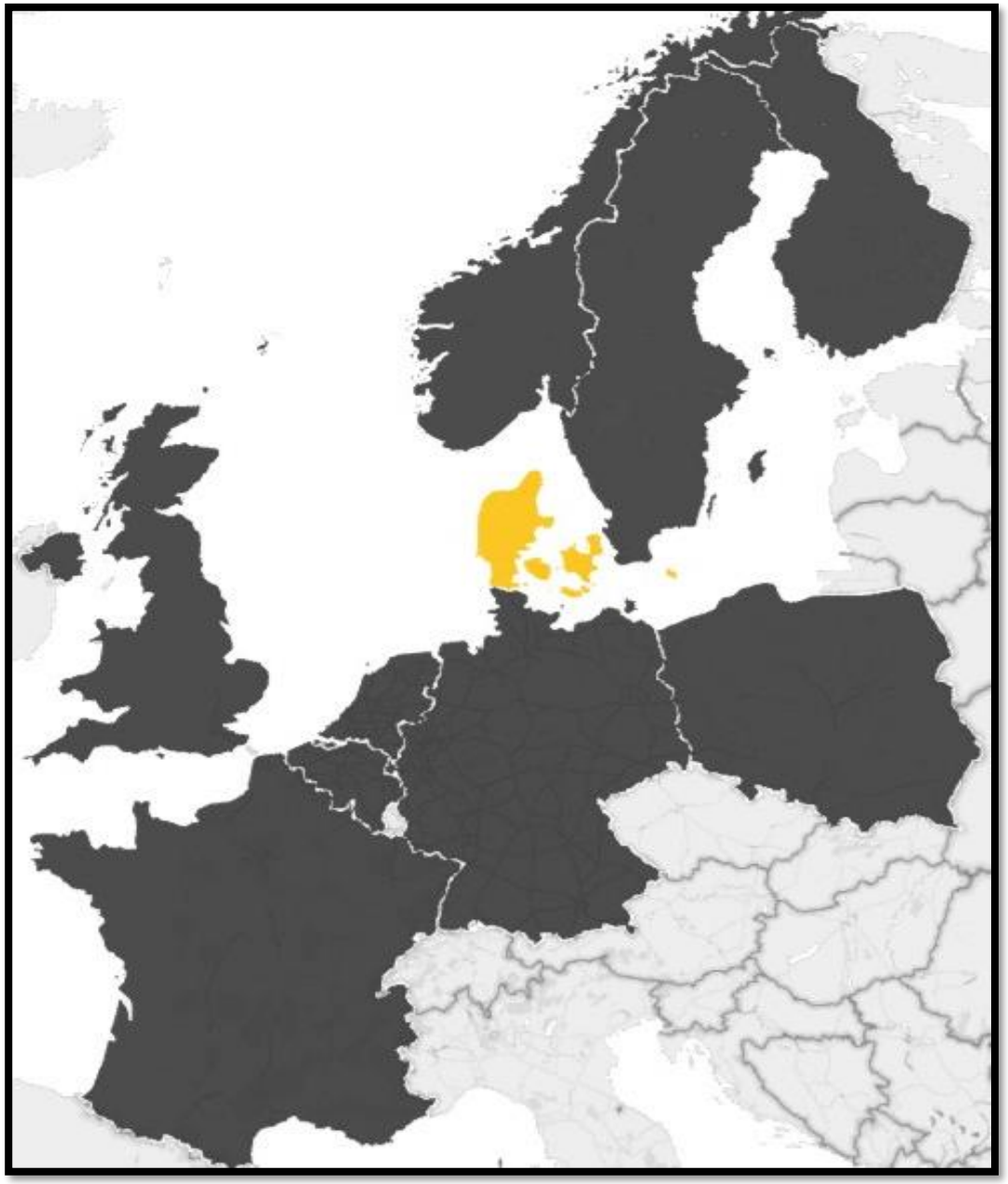
F – FUEL SUBSTITUTION

TITLE*:*

Increased heat-electricity sector coupling by constraining biomass use?

CONTEXT

- Scope: Northern Europe
- Changes: Denmark
- Years: 2025-35-45

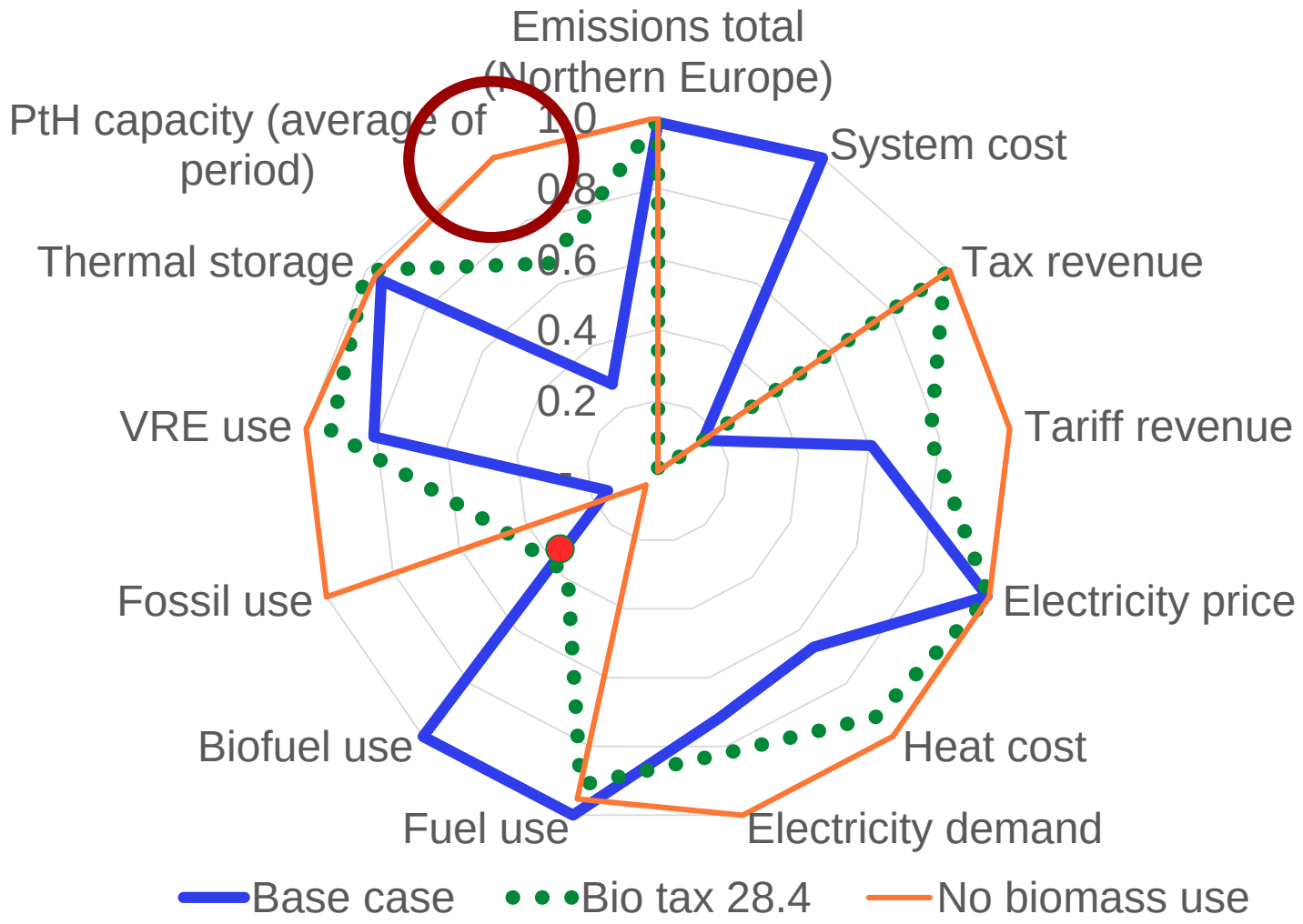


SCENARIOS

Scenario	Base case	Biomass tax [2012-EUR/MWhfuel on biomass use]				No biomass boilers	No biomass use
#	1	2	3	4	5	6	7
Constraint	No constraints	7.1	14.2	21.3	28.4	No use/ investment in bioboilers	No use of biomass

2013 PROPOSED BIO TAX

RESULTS: BASE CASE VS. CONSTRAINTS

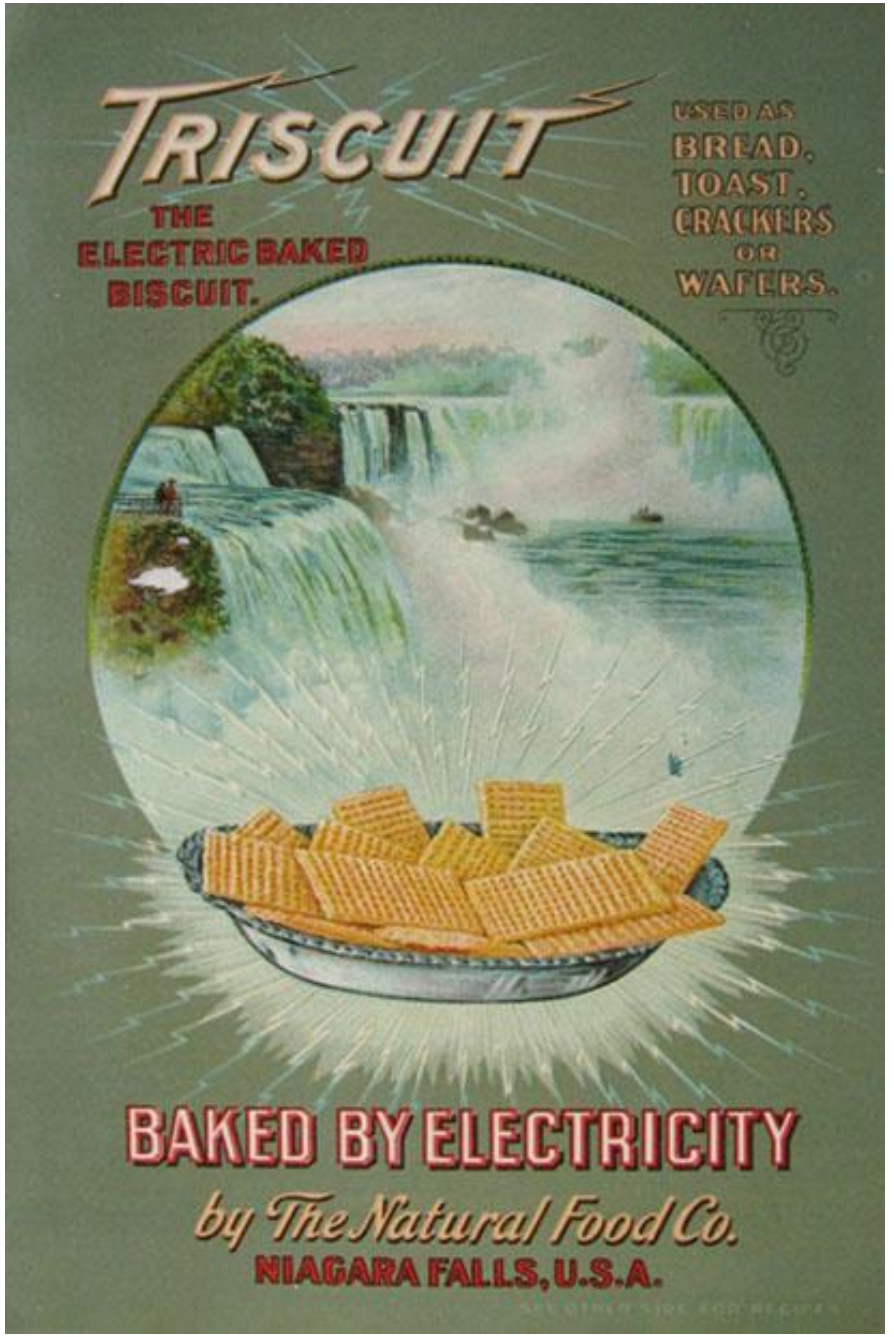


FUEL SUBSTITUTION IN SUMMARY

Is electrification a Triscuit?

- Fuel substitution: PtH capacity increases to 122%-491% compared to *Base case*

- Strong CO_2-price + constrained biomass:
  - ↑ emissions (100.17%-101.49%)
  - ↓ system cost (<0%-22%)
  - ↑ tax revenue (222%-636%)
  - ↑ heat cost (108%-151%)



https://commons.wikimedia.org/wiki/File:Triscuit_1903_Advertisement.jpg

6. CONCLUSIONS + CONTRIBUTIONS

CONTRIBUTIONS

UNDERSTANDING BARRIERS: TAXONOMY

- **First comprehensive overview** of barriers to flexible DE
- Taxonomy **useful for the broader energy research community** with few adaptations: Identifying barriers in other technologies

KEY POINTS

Taxonomy identifies barriers to flexibility in district energy **+ other sectors**

Taxes + tariffs strike the right balance between molecules and electrons

Constraining biomass increases CO_2 – compensate with cost savings

No barriers insurmountable to achieve flexibility in the interface between district energy and the electricity system

ACKNOWLEDGEMENT + DISCLAIMER

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Smart Energy Systems ERA-Net

FlexSUS