#EnergyProspectives

Energy Prospectives

Ignacio Pérez-Arriaga

Fundación Naturgy

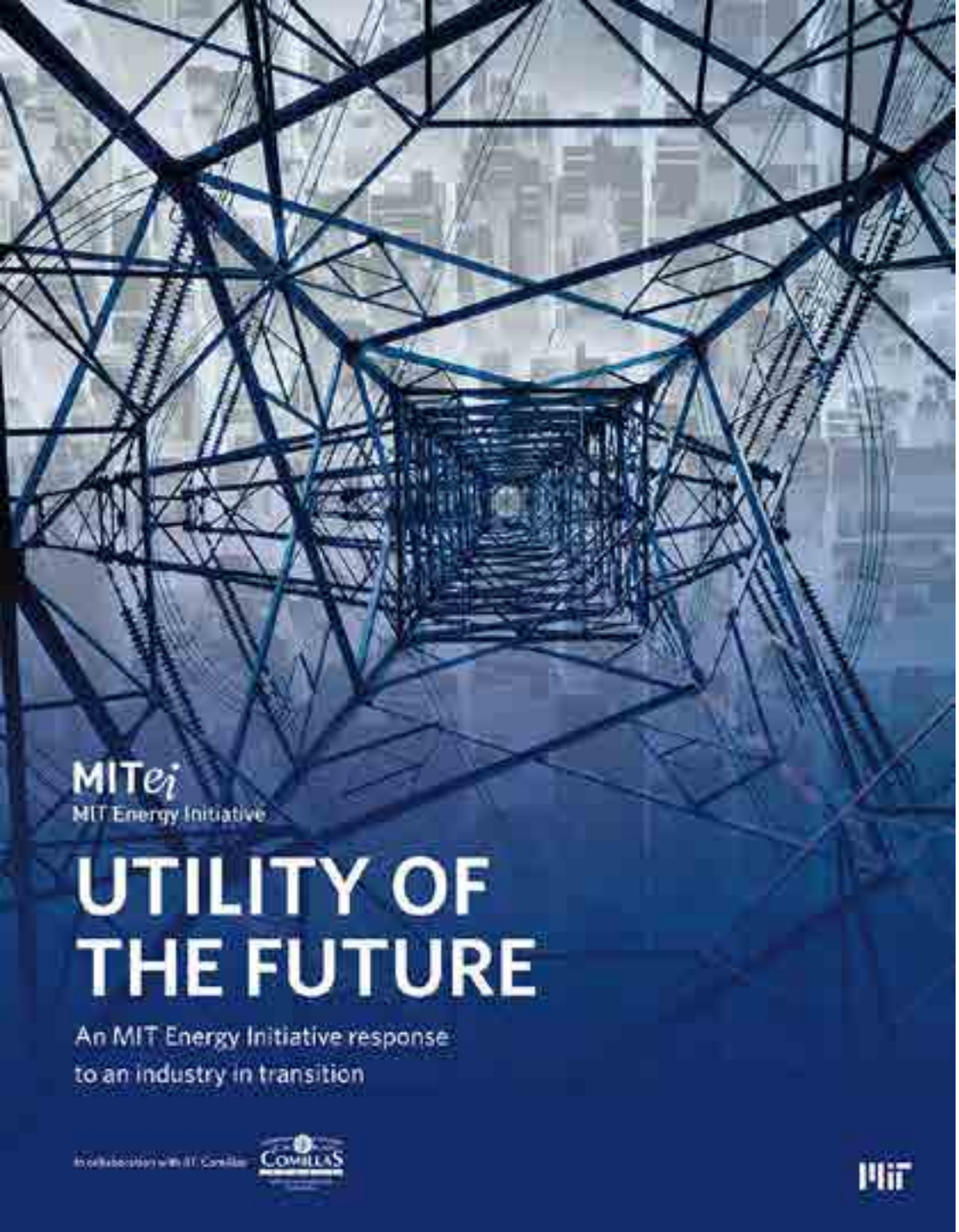
IESE Business School University of Navarra

Energy Prospectives

Utilities of the Future

June 20th, 2019
IESE, Madrid

Ignacio Pérez-Arriaga
Sloan School, MIT
IIT, Comillas University
Florence School of Regulation, EUI



Utility of the Future

June 14th 2017
IESE, Madrid

MITei
MIT Energy Initiative

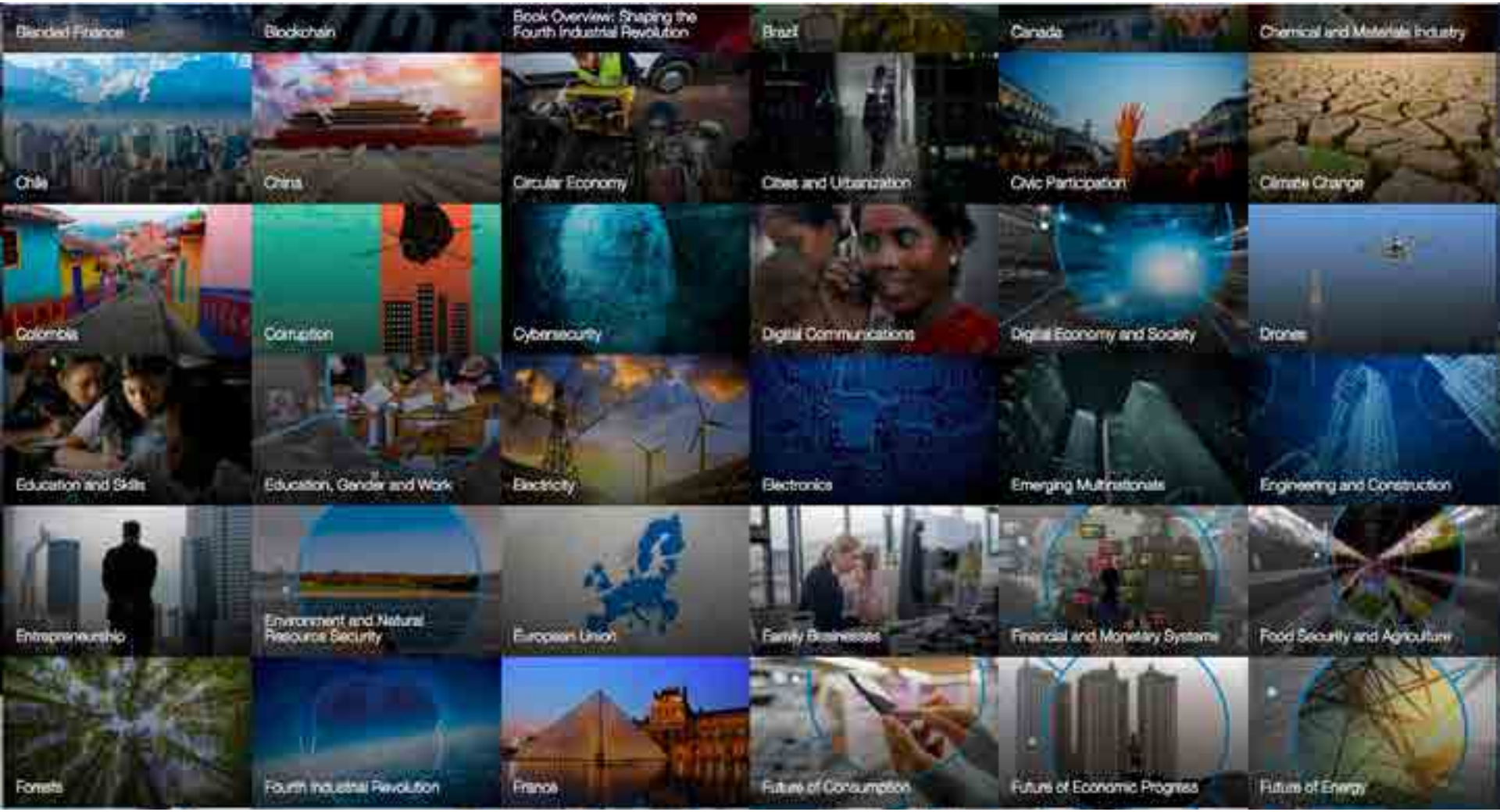
UNIVERSIDAD PONTIFICIA ICAI ICADE
COMILLAS
MADRID
INSTITUTO DE INVESTIGACIÓN TECNOLÓGICA

“As for the future, your role is not to foresee, but to enable it”

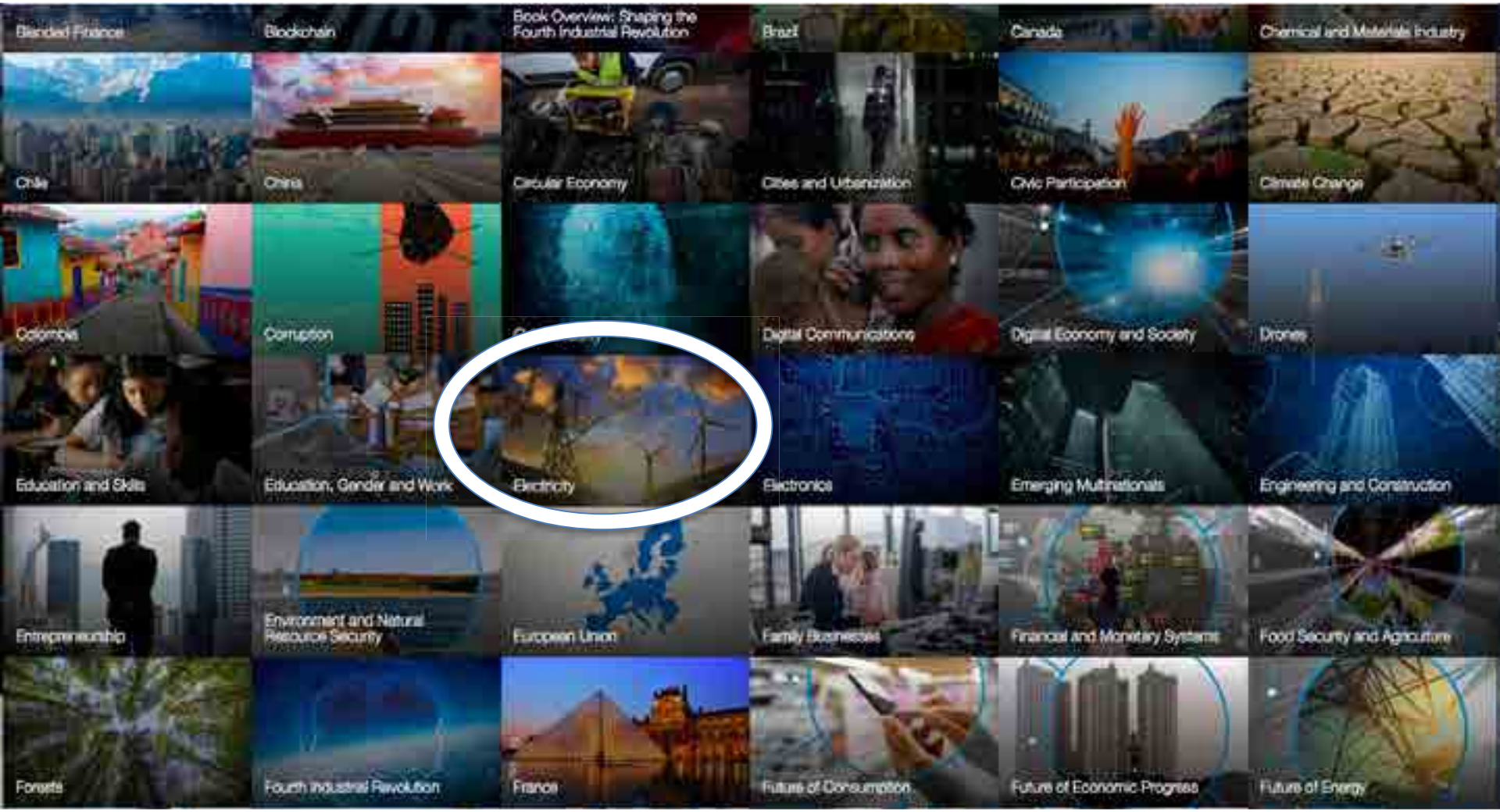
Antoine de Saint Éxupéry

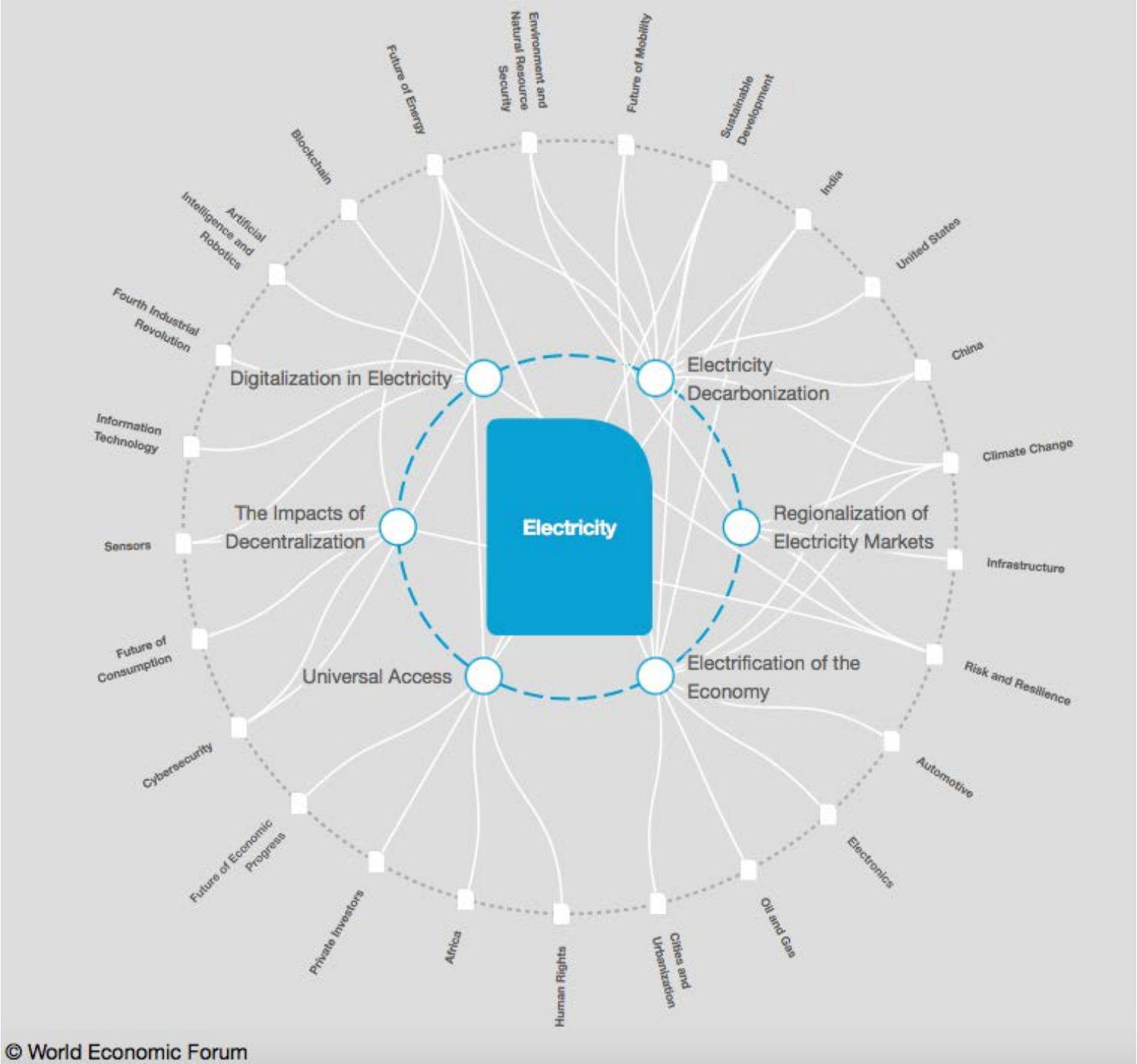
The context

Davos Economic Forum: Transformation Maps



Davos Economic Forum: Transformation Maps





Electricity decarbonization
Electrification of the economy
Decentralization
Digitalization
Regionalization
Universal access
Urbanization?

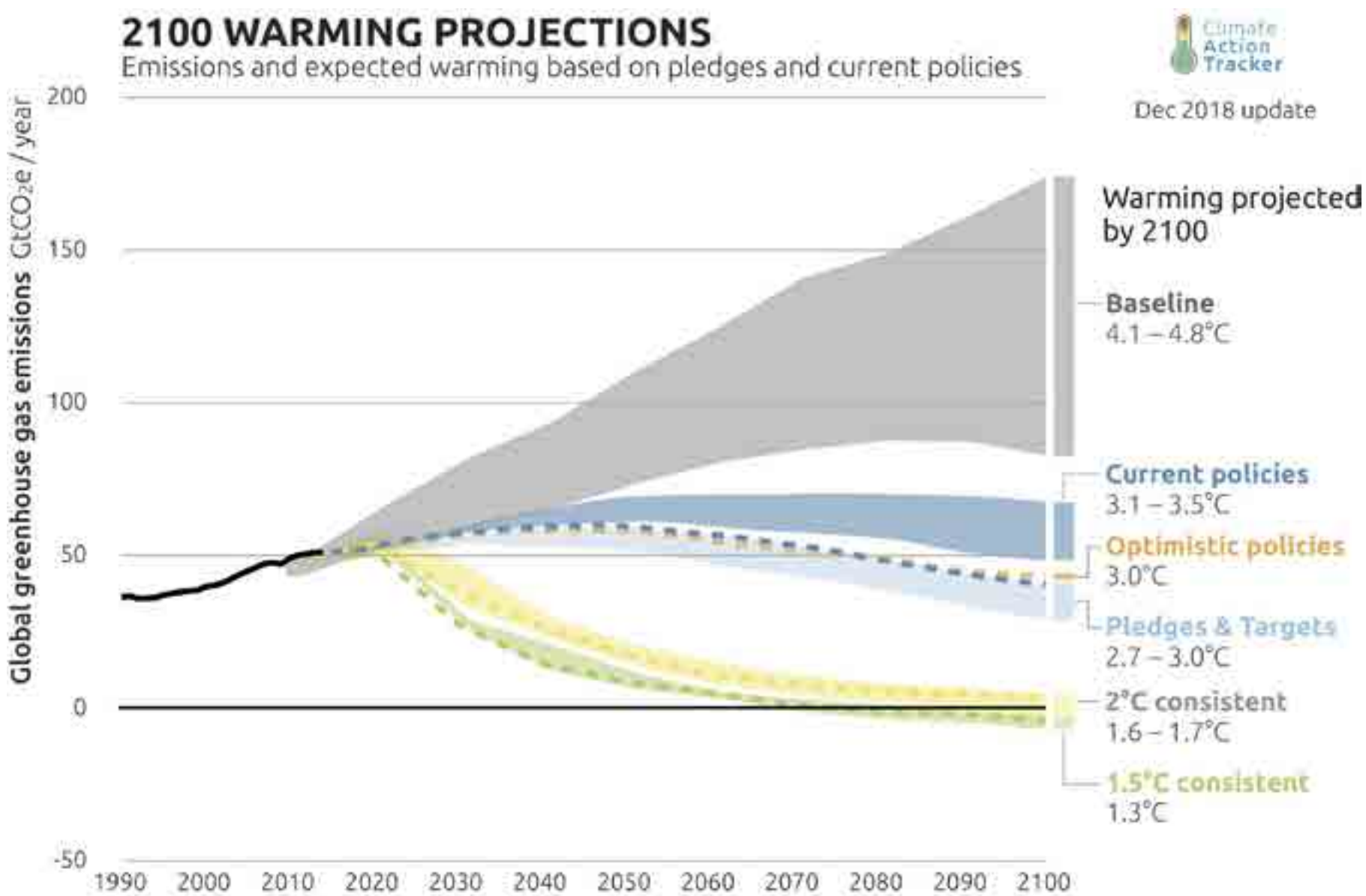
- Electricity decarbonization
- Electrification of the economy
- Decentralization
- Digitalization

Regionalization

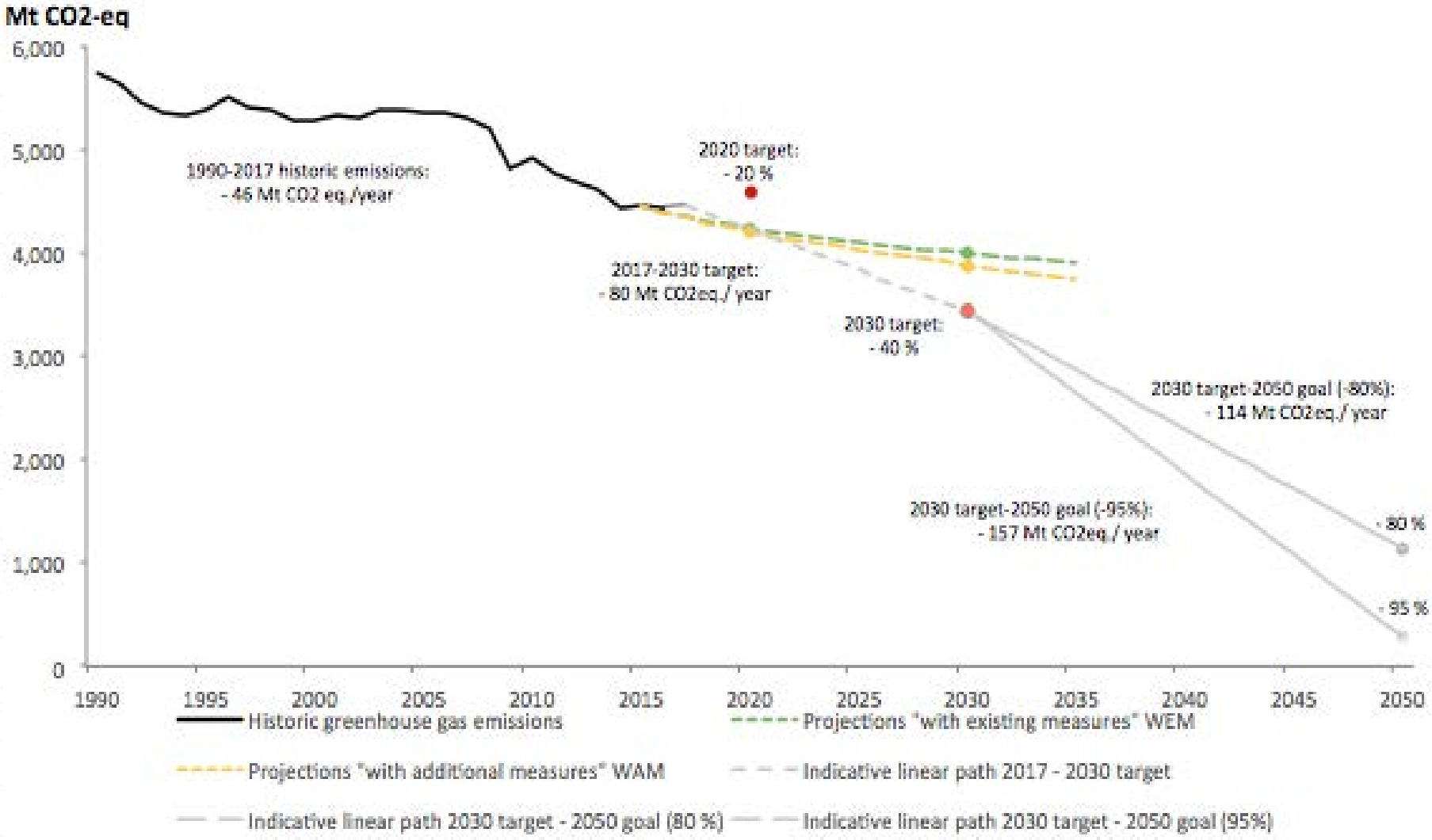
Universal access

Urbanization?

Decarbonization…


2100 WARMING PROJECTIONS
Emissions and expected warming based on pledges and current policies
Climate Action Tracker
Dec 2018 update
Global greenhouse gas emissions GtCO2e / year
200
150
100
50
0
-50
1990
2000
2010
2020
2030
2040
2050
2060
2070
2080
2090
2100
Warming projected by 2100
Baseline
4.1 – 4.8°C
Current policies
3.1 – 3.5°C
Optimistic policies
3.0°C
Pledges & Targets
2.7 – 3.0°C
2°C consistent
1.6 – 1.7°C
1.5°C consistent
1.3°C

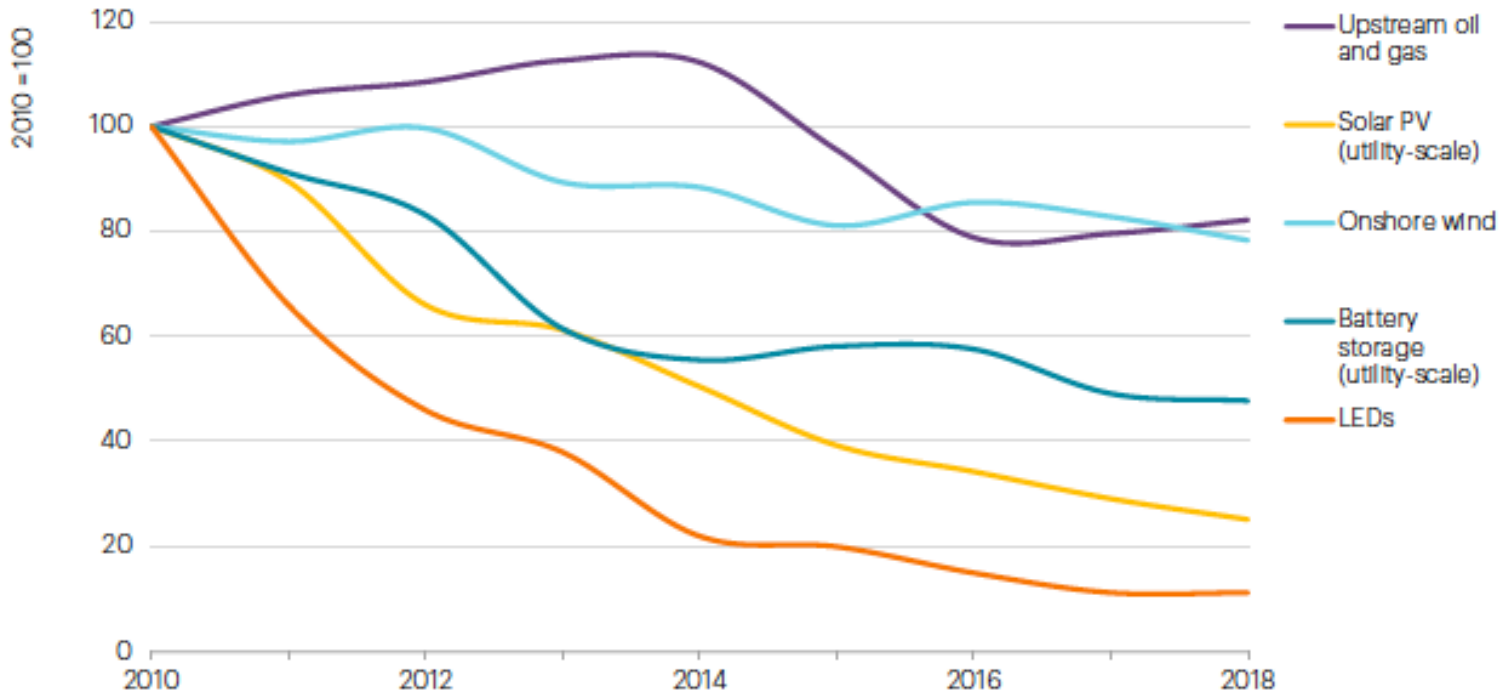
EU emissions 1990-2050



& technological progress in costs & performance…

Changing costs have reshaped the investment landscape in some areas

Capital costs in selected energy-related sectors



Note: LEDs = light-emitting diodes, PV = photovoltaic. Capital costs reflect global weighted average costs of components or commissioned projects in a given sector.

Source: IEA analysis with calculations for solar PV and wind costs based on IRENA (2019).

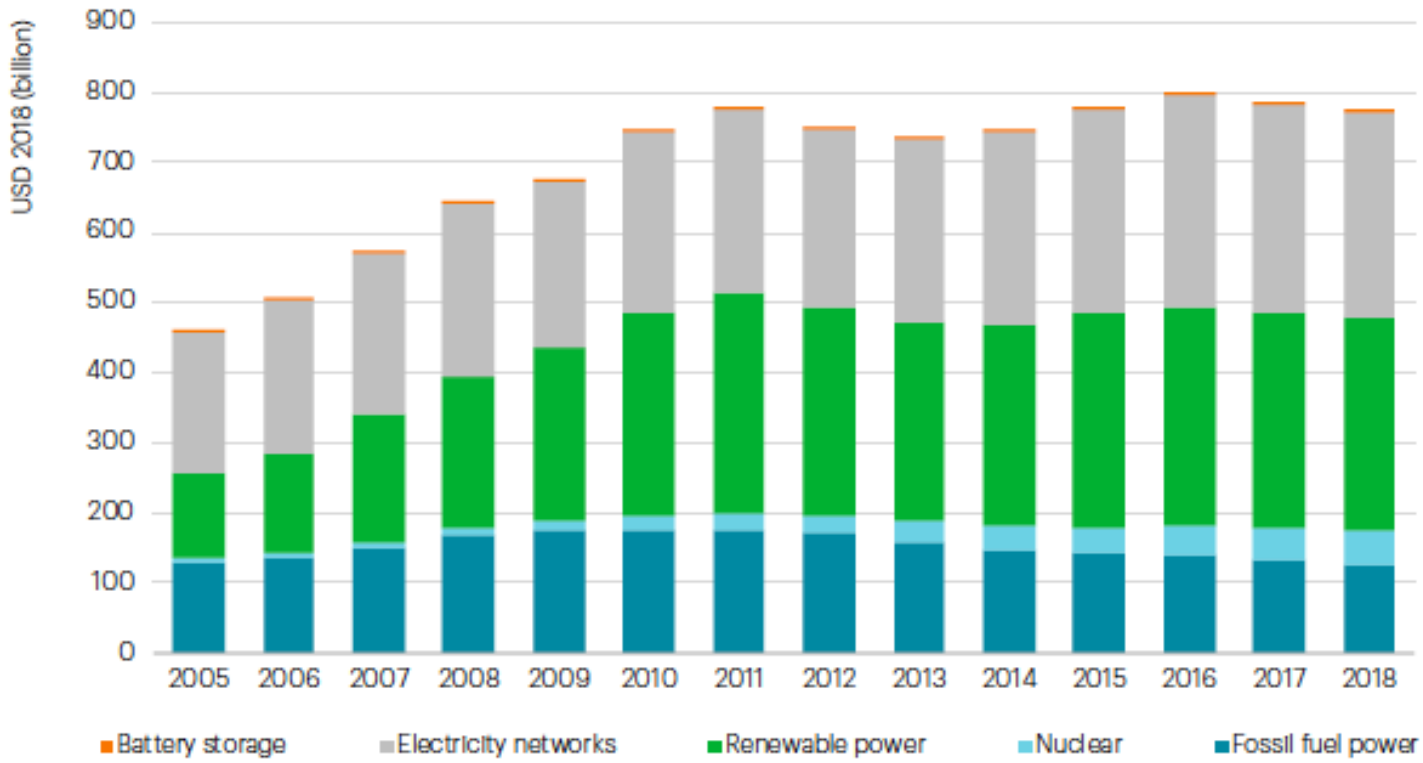
… are driving investment…

World Energy Investment 2019

iea.org/wei2019

Global electricity investment declined by 1% in 2018...

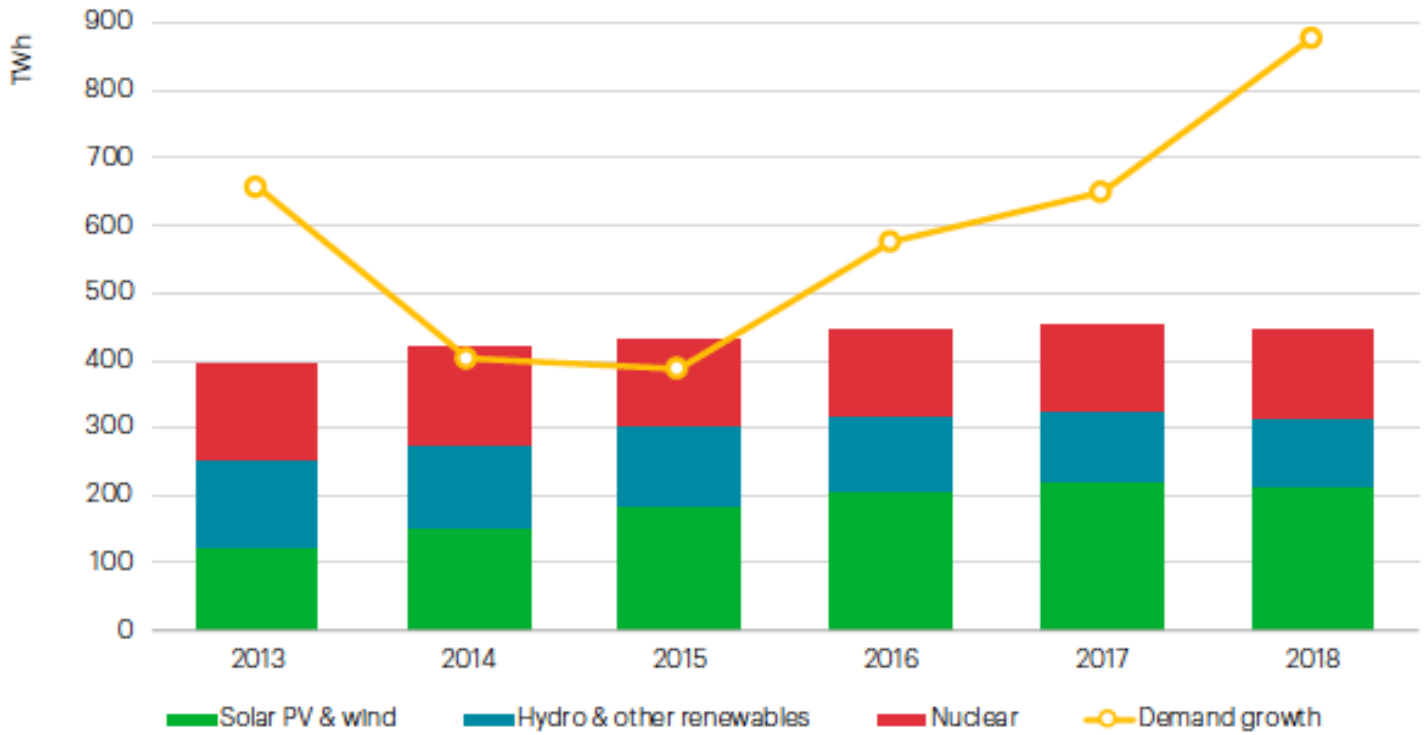
Global investment in the power sector by technology



Note: Investment is measured as the ongoing capital spending in power capacity. The scope and methodology for tracking energy investments is found in the Annex of this report as well as at iea.org/media/publications/wei/WEI2019-Methodology-Annex.pdf.

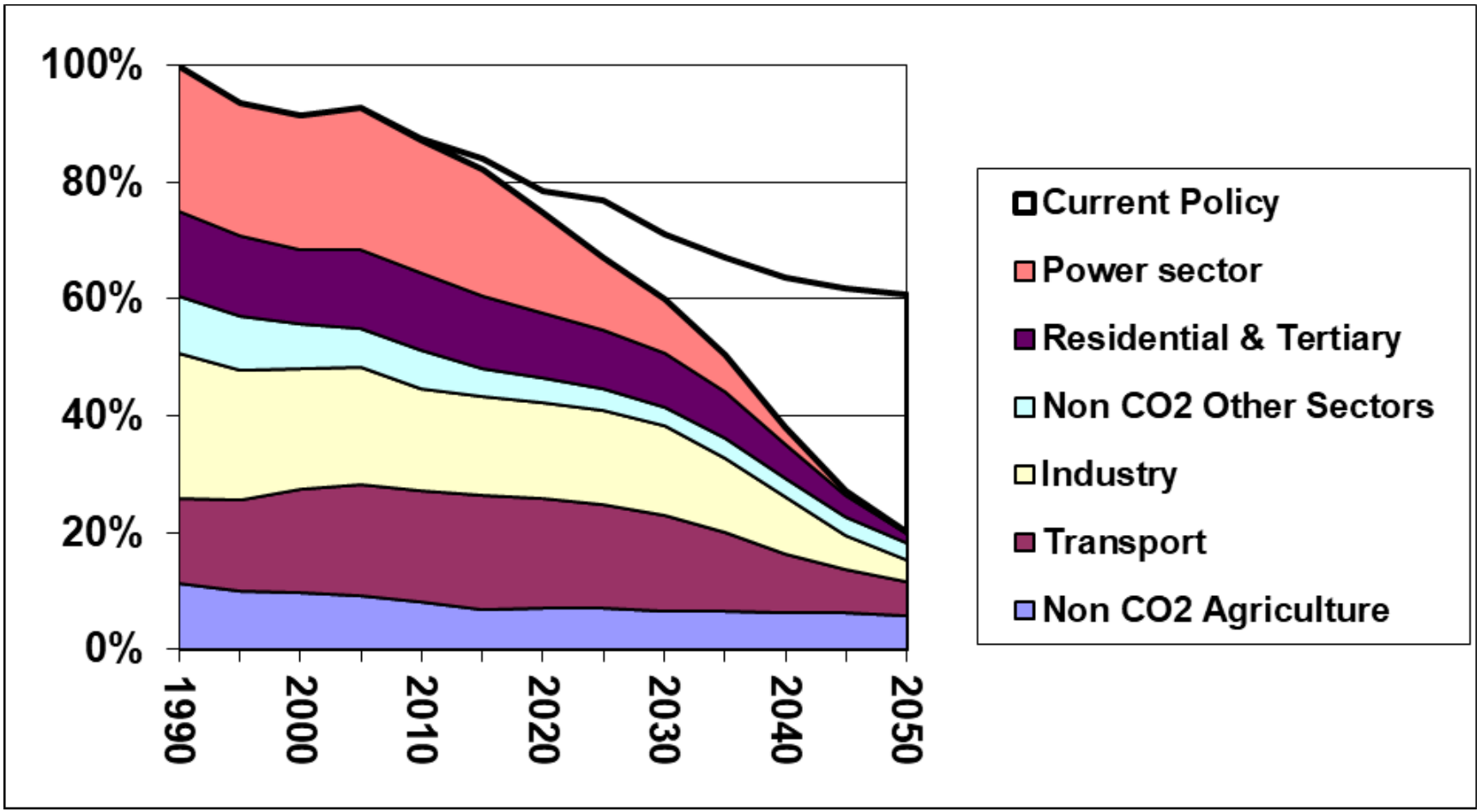
Despite recent progress, the expected output from low-carbon power investments is not keeping pace with demand growth

Expected generation from low-carbon power investments compared to electricity demand growth



Note: Expected generation is based on the expected annualised output of the capacity associated with investment in a given year. TWh = terawatt hour. NPS = New Policies Scenario; SDS = Sustainable Development Scenario.

Sectoral GHG 1990-2050
EU ROADMAP 2050



Decentralization, supported by digitalization, guided by decarbonization & needed for electrification, drives the change in how electricity services will be provided in the future

Exuberance over DERs has led some to proclaim an imminent DER revolution:

"rooftop solar, energy storage (from household batteries to electric vehicles), smart energy management technology, and the aggregation of demand are all areas where demand, rather than generation, can become [New York's] primary energy resource"

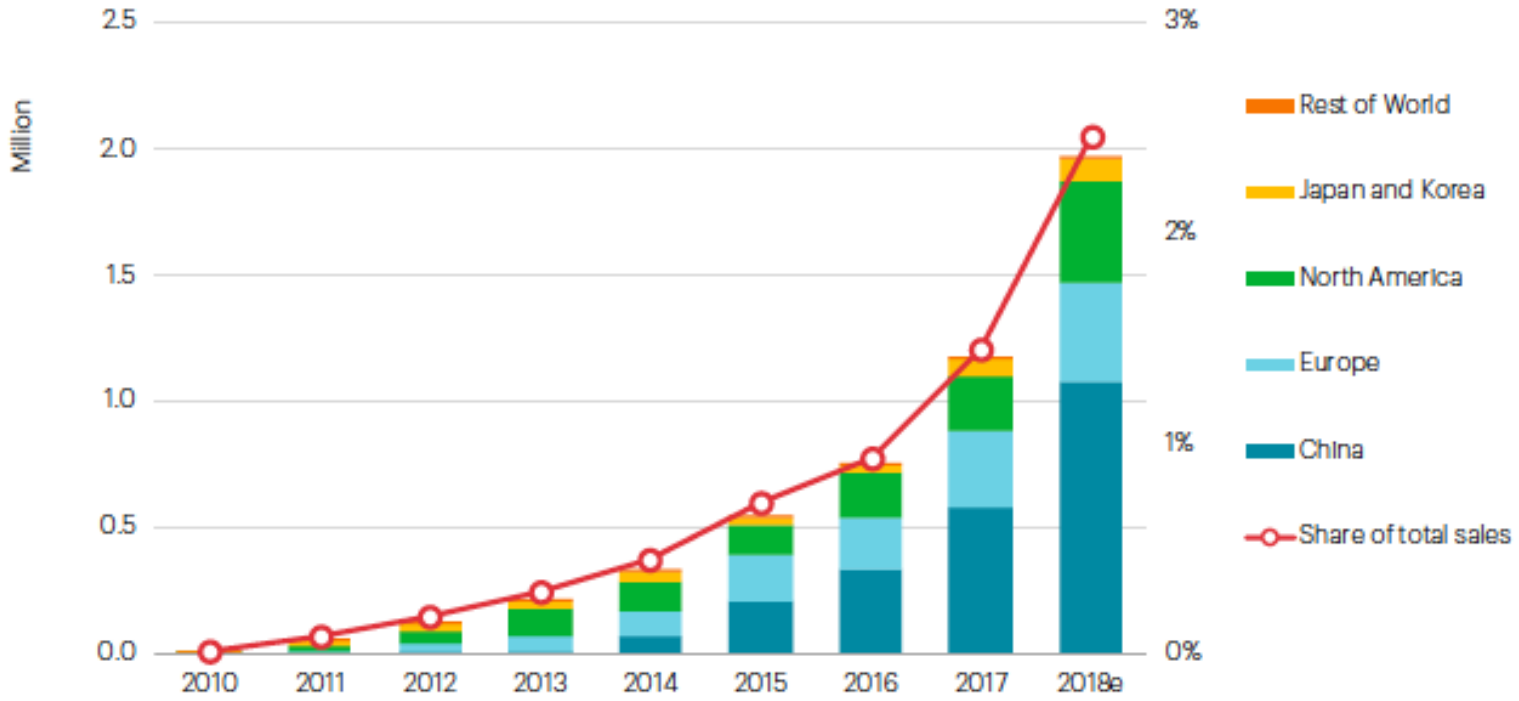
Audrey Zibelman
CEO, Australian Energy Market Operator
Former Chair, New York Public Service Commission

DERs are happening in large amounts

Today there are more than 1.5 million solar homes in the U.S., representing over 16.5GW of capacity

Electric car sales continued to soar, with nearly 70% growth in 2018...

Electric passenger light duty vehicle sales and market share, from the forthcoming IEA Global Electric Vehicle Outlook

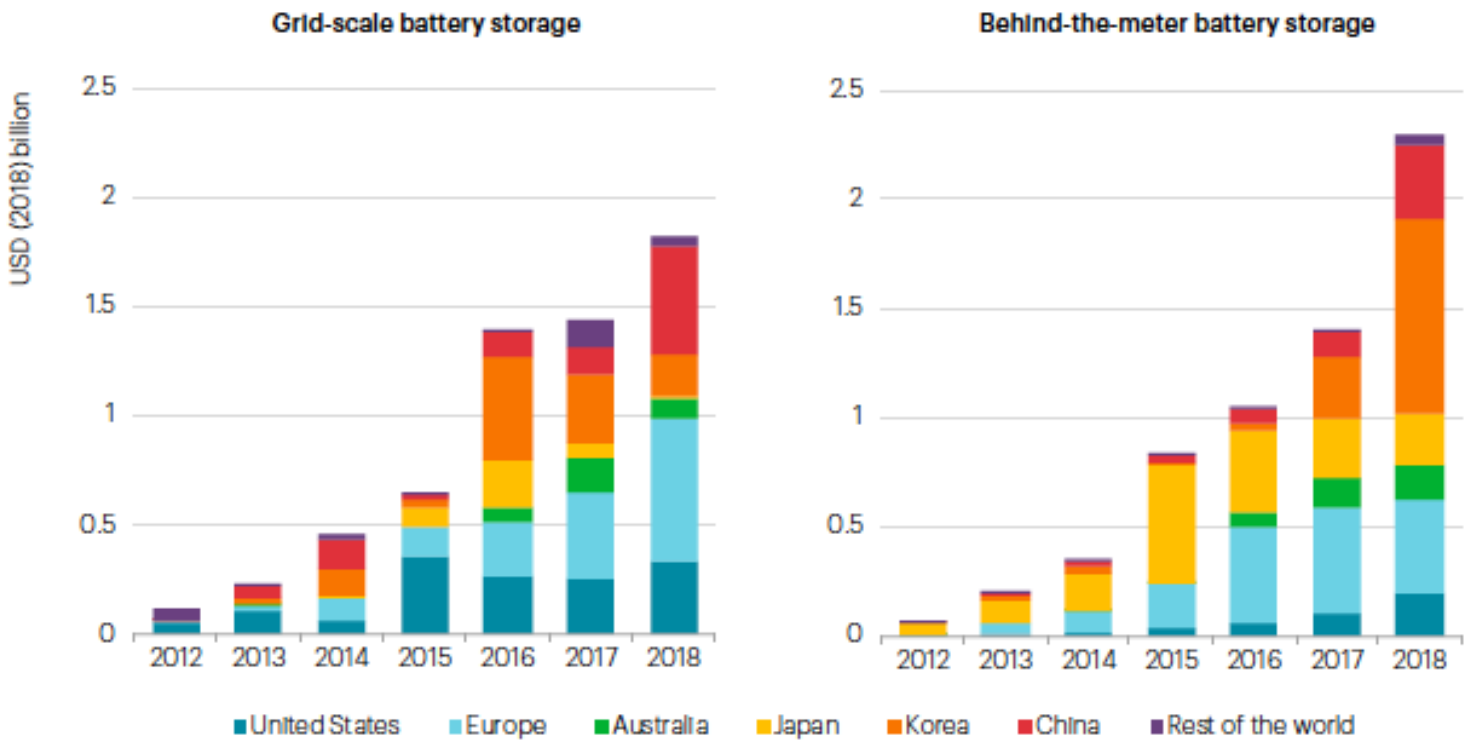


Note: Includes passenger cars and passenger light trucks. Includes plug-in hybrids, battery electric vehicles and fuel cell electric vehicles. Share of total sales represents the total sales of electric vehicles in countries listed in IEA Global Electric Vehicle Outlook as a percentage of total passenger car sales in those same countries.

Source: (IEA 2019b, forthcoming).

Investment in stationary battery storage surged to over USD 4 billion...

Investment in stationary battery storage



Source: IEA analysis with calculations based on Clean Horizon (2019), China Energy Storage Alliance (2019) and BNEF (2019).

The presence of distributed energy resources…

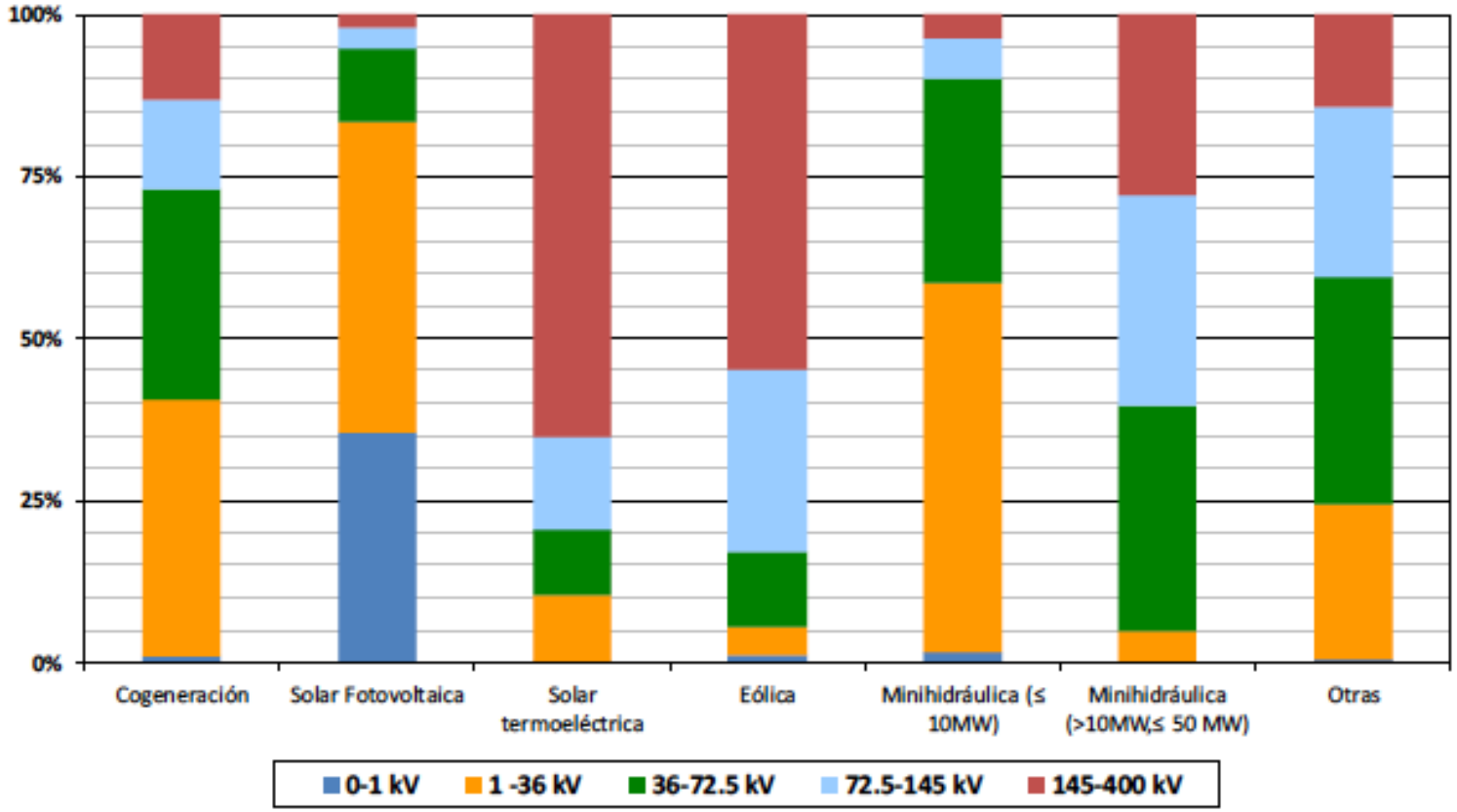
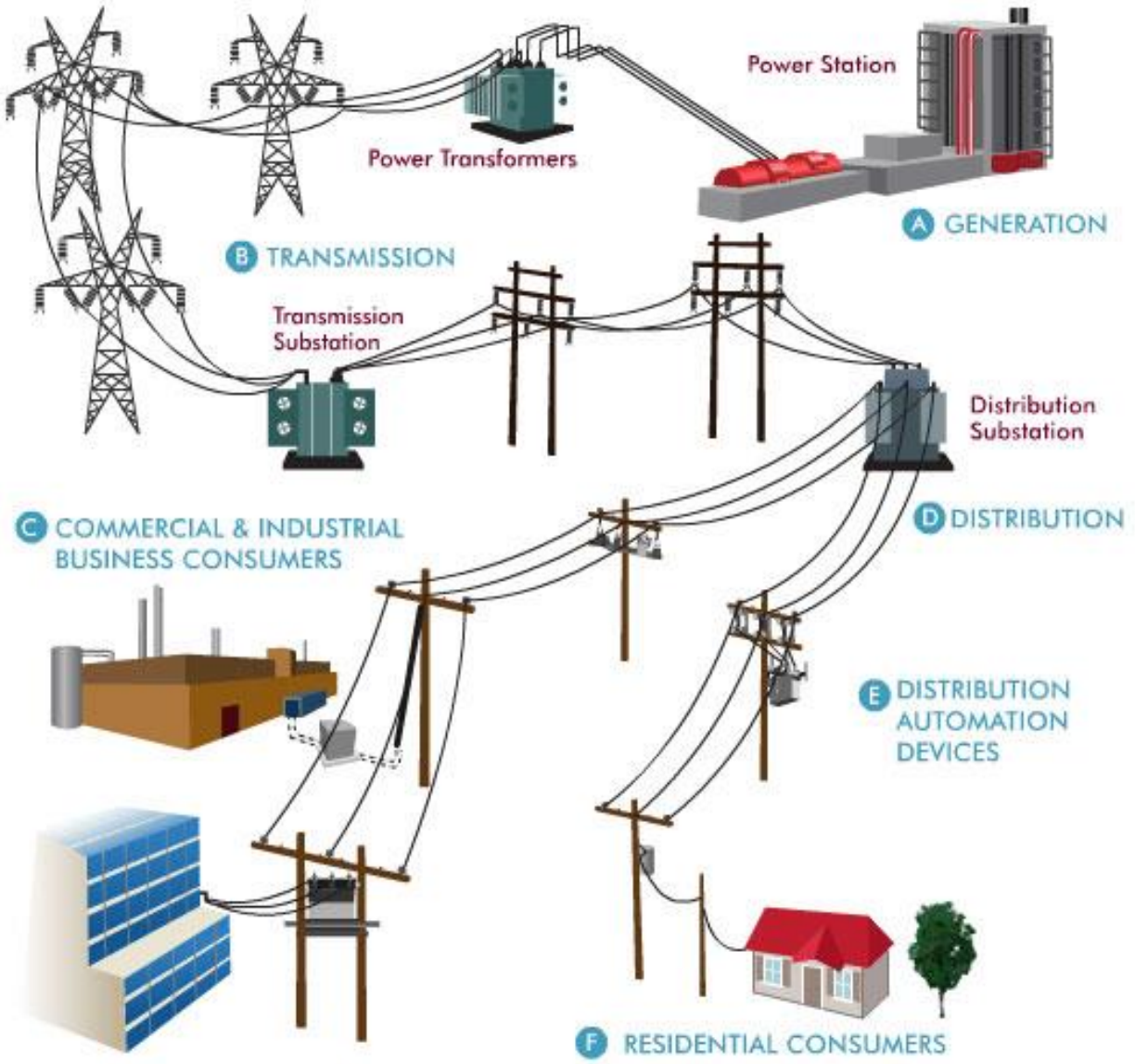
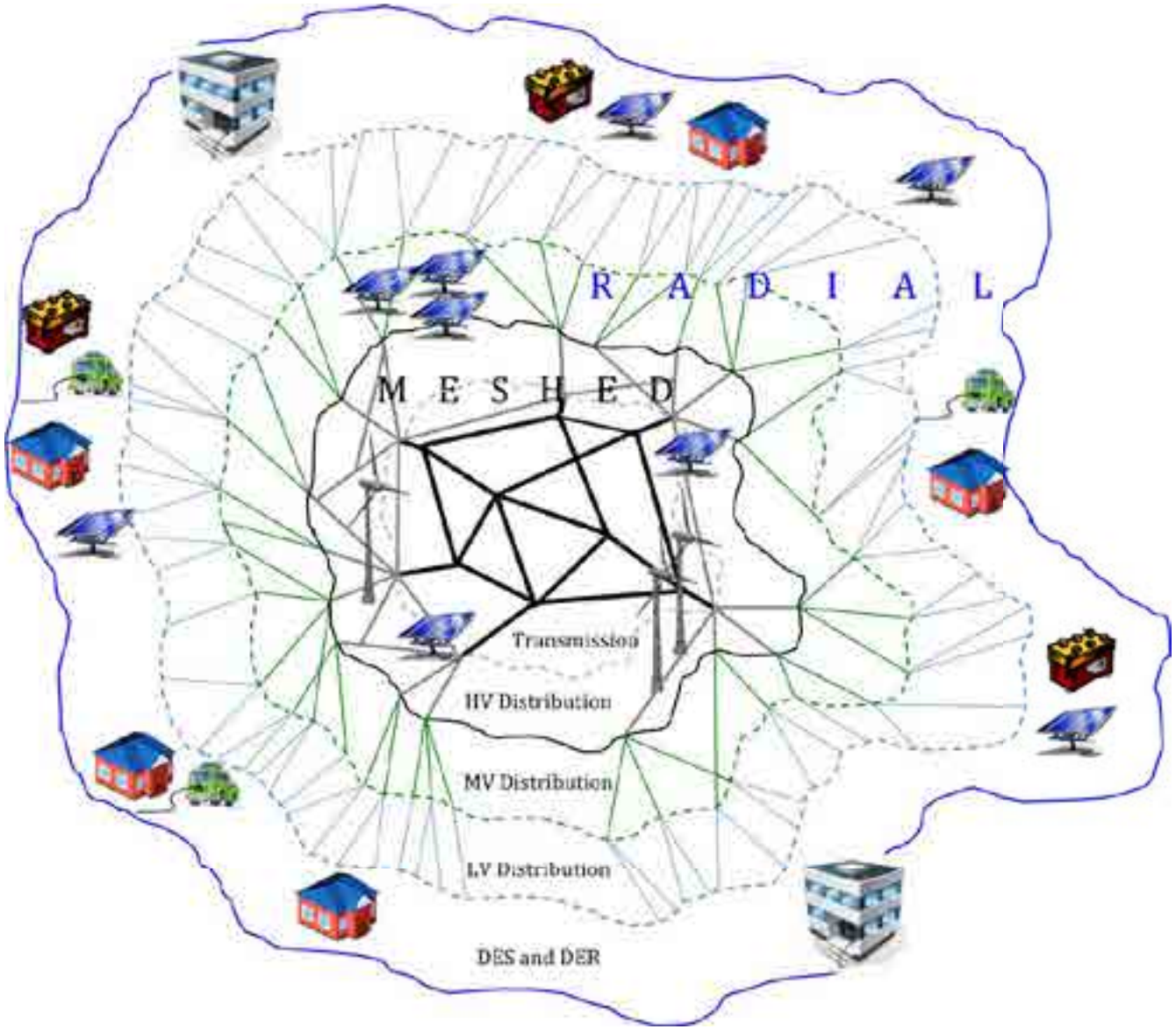


Figura 4-1: Porcentaje capacidad instalada de cada tecnología renovable en España por nivel de tensión (otras tecnologías incluye: biomasa, residuos, tratamiento de residuos e hidráulica marina). Fuente: elaboración propia con datos de (CNMC, 2018)

… forces us to change the “top-down” perspective…



… and adopt one where there is no clear dominance between centralized and distributed

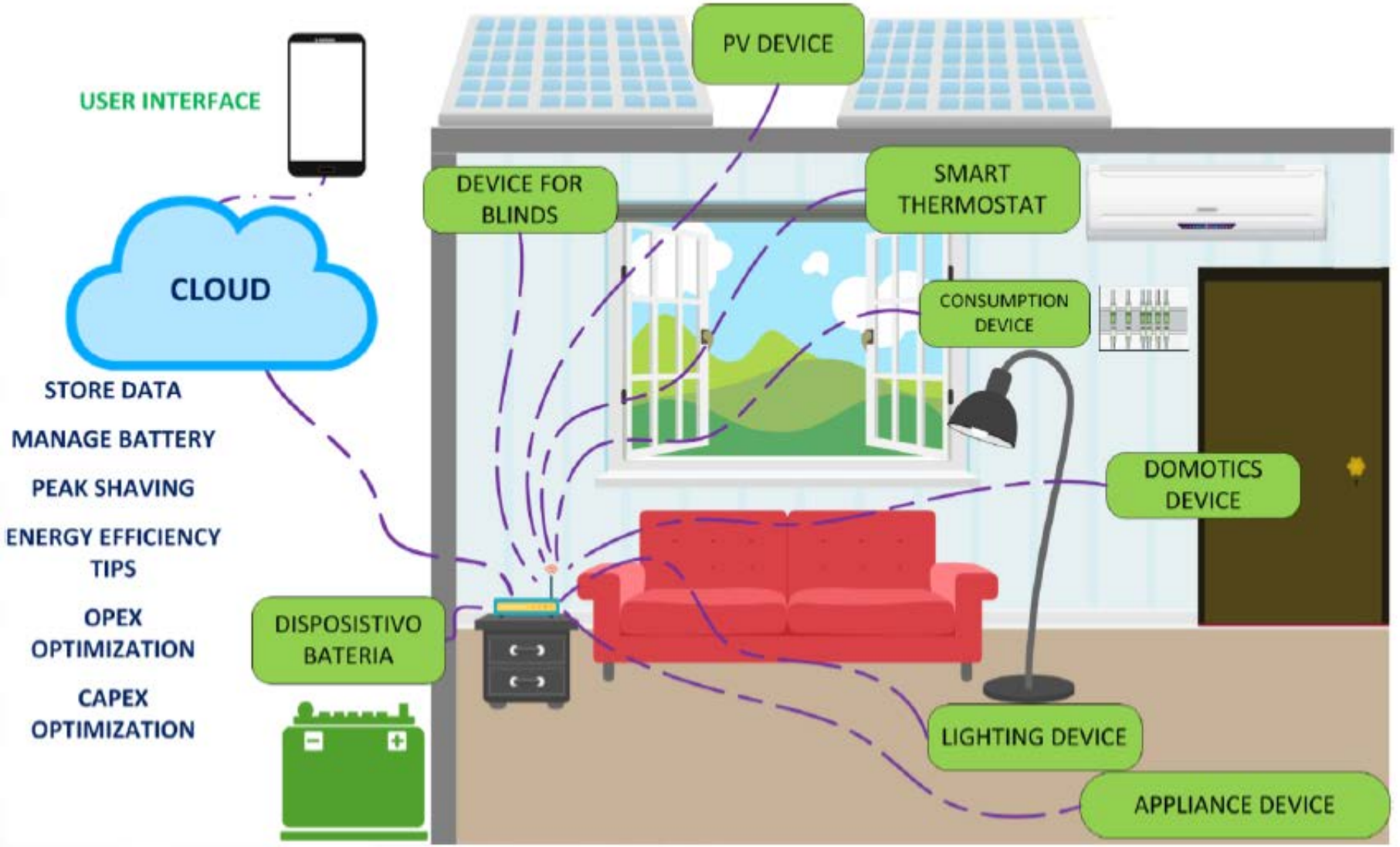


DERs can be installed in a short amount of time

Use of DERs can save infrastructure investments

DERs provide unprecedented level of choice to customers to express their preferences…

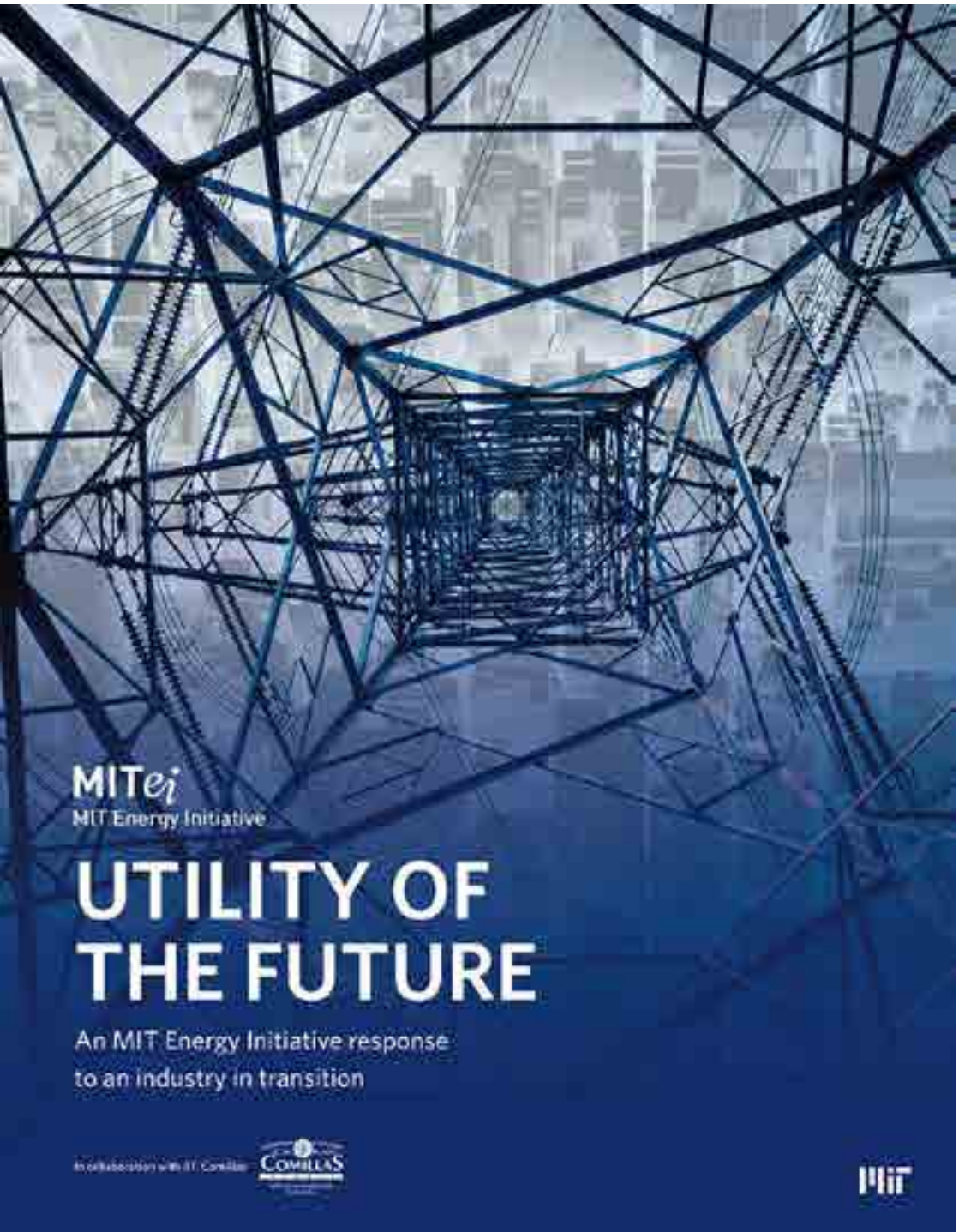
… & technologies are ready to allow the customer choose how to use energy…



But **many opportunities** of DERs to provide value to the power system **go unused**

Flexible demand & smart thermostats are only useful if able to respond to **changing system conditions**

What is missing?
A comprehensive system of efficient prices & regulated charges
for electricity services



Our key recommendations

1

"Create a comprehensive & efficient system of prices & charges"

The only way to put all resources – **centralized & distributed**– on a **level playing field** and achieve efficient operation and planning in the power system is to **dramatically improve prices and regulated charges** for electricity services.


Prices & signals are
the nervous system
of the electricity sector,
reaching everywhere

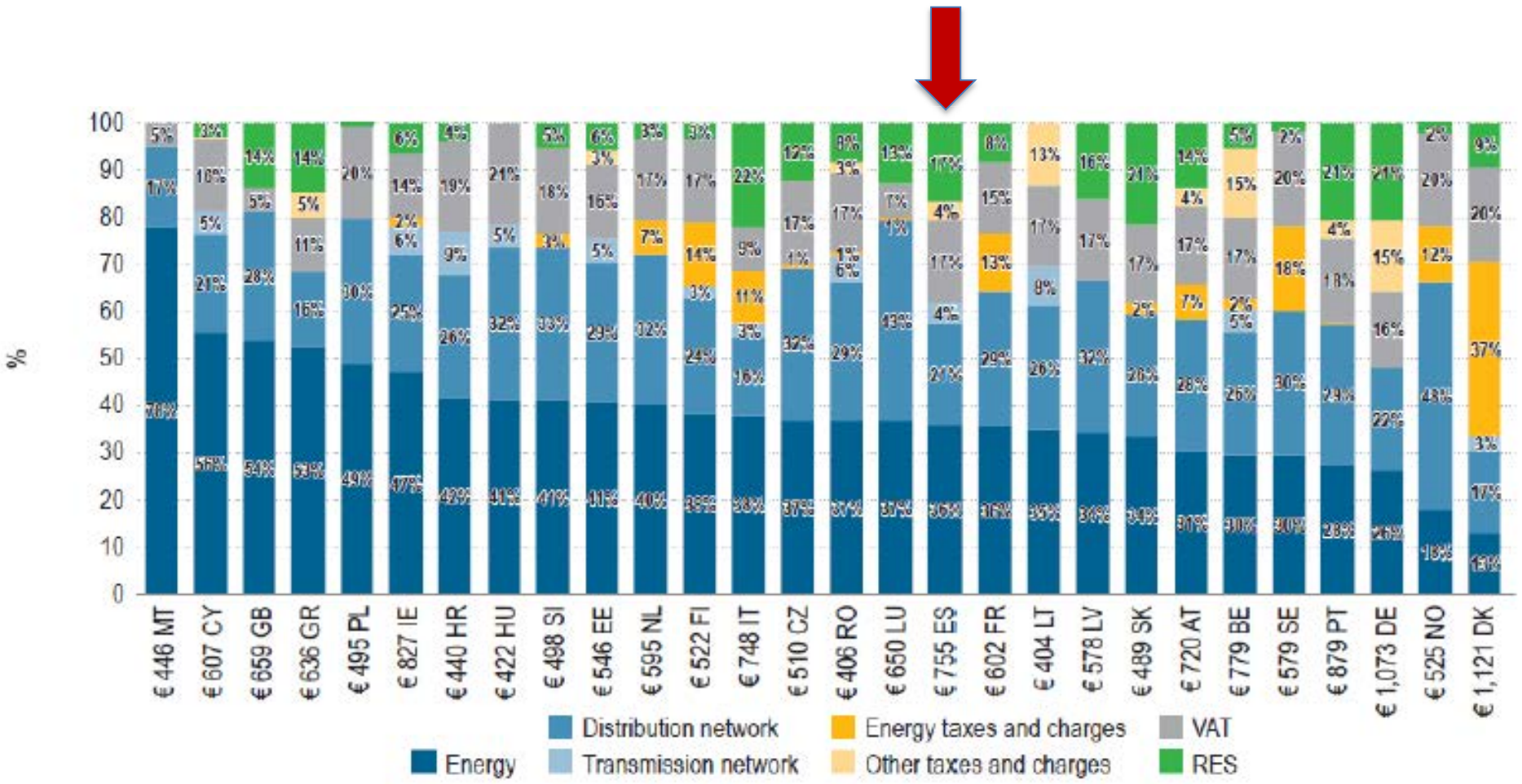


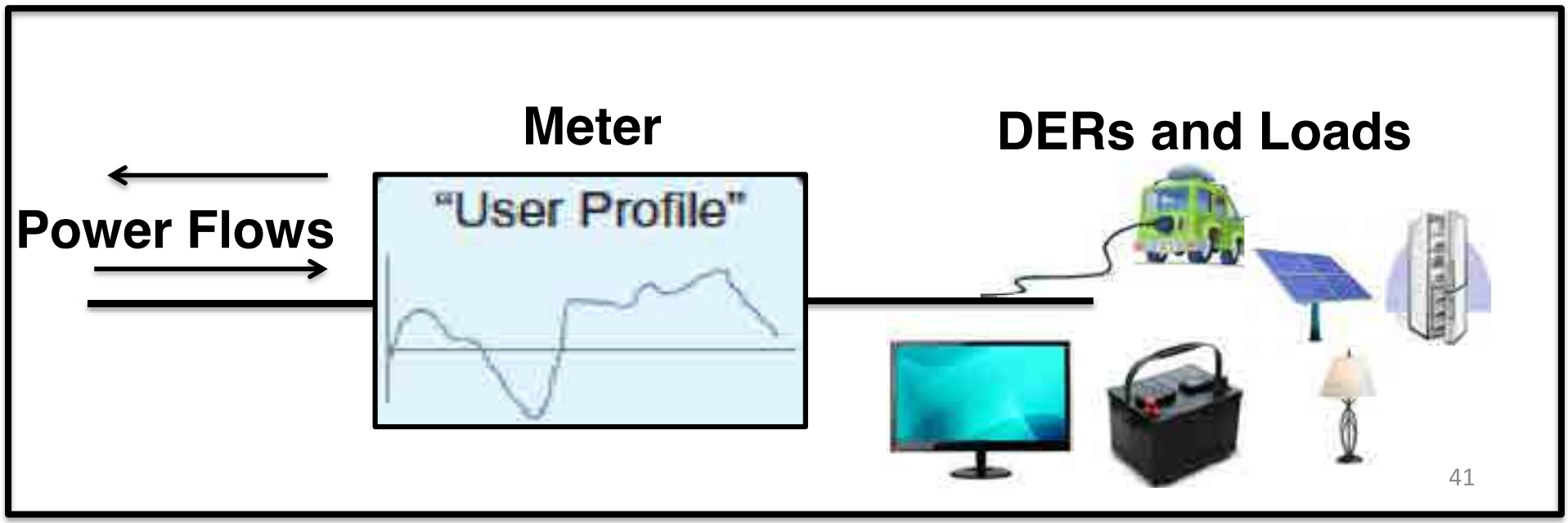
Figura 7-1.- *Descomposición de precios finales de electricidad para consumidores residenciales en capitales de la Unión Europea, Noviembre-Diciembre 2016. Fuente: (ACER, 2017).*

Any **cost-reflective** component of prices & charges should be exclusively based on the **individual injection & withdrawal profiles** at the network connection point & should be **symmetrical**.

This requires the use of **advanced meters**

Any **cost-reflective** component of prices & charges should be exclusively based on the **individual injection & withdrawal profiles** at the network connection point & should be **symmetrical**.

This requires the use of **advanced meters**



BOLETÍN OFICIAL DEL ESTADO
Núm. 83 Sábado 6 de abril de 2019 Sec. I. Pág. 35674

I. DISPOSICIONES GENERALES

MINISTERIO PARA LA TRANSICIÓN ECOLÓGICA

5089 *Real Decreto 244/2019, de 5 de abril, por el que se regulan las condiciones administrativas, técnicas y económicas del autoconsumo de energía eléctrica.*

I

La Ley 24/2013, de 26 de diciembre, del Sector Eléctrico, en la dicción original del artículo 9, definía el autoconsumo como el consumo de energía eléctrica proveniente de instalaciones de generación conectadas en el interior de una red de un consumidor o a través de una línea directa de energía eléctrica asociadas a un consumidor y distinguía varias modalidades de autoconsumo.

Al amparo de dicha dicción, el 10 de octubre de 2015 fue publicado en el «Boletín Oficial del Estado» el Real Decreto 900/2015, de 9 de octubre, por el que se regulan las condiciones administrativas, técnicas y económicas de las modalidades de suministro de energía eléctrica con autoconsumo y de producción con autoconsumo. Este reglamento

AUTOCONSUMO

BOLETÍN OFICIAL DEL ESTADO
Núm. 11 Sábado 12 de enero de 2019 Sec. I. Pág. 2219

I. DISPOSICIONES GENERALES

JEFATURA DEL ESTADO

315 *Real Decreto-ley 1/2019, de 11 de enero, de medidas urgentes para adecuar las competencias de la Comisión Nacional de los Mercados y la Competencia a las exigencias derivadas del derecho comunitario en relación a las Directivas 2009/72/CE y 2009/73/CE del Parlamento Europeo y del Consejo, de 13 de julio de 2009, sobre normas comunes para el mercado interior de la electricidad y del gas natural.*

I

La consecución de verdaderos mercados interiores de electricidad y gas natural son el objetivo fundamental de la Directiva 2009/72/CE del Parlamento Europeo y del Consejo de 13 de julio de 2009 sobre normas comunes para el mercado interior de la electricidad y de la Directiva 2009/73/CE del Parlamento Europeo y del Consejo de 13 de julio de 2009 sobre normas comunes para el mercado interior del gas natural. En particular, estas directivas establecen que, para un adecuado funcionamiento de los mercados interiores de la electricidad y del gas natural, los reguladores de la energía deben poder tomar decisiones sobre todas las cuestiones de reglamentación pertinentes y que sean totalmente independientes de cualquier otro interés público o privado.

Por otra parte, en el contexto de la transición energética actual tanto a nivel europeo como nacional, nuestro país debe adoptar un marco regulatorio e institucional claro, estable y predecible que otorgue seguridad jurídica a todos las personas físicas y jurídicas relacionadas con el sector energético, cuya transversalidad engloba tanto a colectivos vulnerables como a inversores nacionales e internacionales.

Asimismo, y en conexión con lo anterior, cabe señalar como la Comisión Europea inició de oficio una investigación sobre la transposición de la Directiva 2009/72/CE y de la Directiva 2009/73/CE a la legislación española, con el fin de evaluar la posible falta de conformidad con la legislación de la Unión Europea, que culminó en septiembre de 2016 con un Dictamen Motivado dirigido al Reino de España, concluyendo que se habían transpuesto incorrectamente al ordenamiento jurídico español las directivas citadas. A raíz del Dictamen Motivado, y dado el tiempo transcurrido desde su emisión, resulta urgente la adopción de las medidas legislativas necesarias pues, de no hacerlo, existe un inminente riesgo de que la Comisión Europea presente un recurso de incumplimiento contra el Reino de España ante el Tribunal de Justicia de la Unión Europea.

Al mismo tiempo, la incorrecta transposición de las directivas de mercado interior ha provocado una importante litigiosidad ante el Tribunal Supremo entre el regulador nacional y el Gobierno que resulta perjudicial para el interés general y que conlleva incertidumbre jurídica e inestabilidad institucional para todos los agentes involucrados en el sector. La presente norma pone fin a esta situación, realizando un reparto de competencias respetuoso con el marco comunitario, dotando a la Comisión Nacional de los Mercados y la Competencia de la independencia necesaria para el ejercicio de sus funciones.

Por ello, mediante el presente Real Decreto-ley se procede a modificar las leyes afectadas: la Ley 3/2013, de 4 de junio, de creación de la Comisión Nacional de los Mercados y la Competencia; la Ley 34/1998, de 7 de octubre, del sector de hidrocarburos; la Ley 24/2013, de 26 de diciembre, del Sector Eléctrico; y la Ley 18/2014, de 15 de octubre, de aprobación de medidas urgentes para el crecimiento, la competitividad y la eficiencia.

Respecto a las materias objeto de modificación, en primer lugar, se introduce un mecanismo para asegurar la consistencia en el ejercicio de las competencias que corresponden al regulador con la competencia exclusiva sobre bases del régimen energético que el artículo 149.1.25.ª de la Constitución Española atribuye al Estado,

R.D.L.
COMPETENCIAS
CNMC

BOLETÍN OFICIAL DEL ESTADO
Núm. 85 Martes 9 de abril de 2019 Sec. I. Pág. 36392

I. DISPOSICIONES GENERALES

MINISTERIO PARA LA TRANSICIÓN ECOLÓGICA

5244 *Orden TEC/406/2019, de 5 de abril, por la que se establecen orientaciones de política energética a la Comisión Nacional de los Mercados y la Competencia.*

El artículo 1 del Real Decreto-ley 1/2019, de 11 de enero, de medidas urgentes para adecuar las competencias de la Comisión Nacional de los Mercados y la Competencia a las exigencias derivadas del derecho comunitario en relación a las Directivas 2009/72/CE y 2009/73/CE del Parlamento Europeo y del Consejo, de 13 de julio de 2009, sobre normas comunes para el mercado interior de la electricidad y del gas natural, establece en su apartado primero que la Comisión Nacional de los Mercados y la Competencia, en el ámbito de sus competencias de regulación, deberá tener en consideración las prioridades estratégicas establecidas por el Gobierno, que se materializarán en unas orientaciones de política energética adoptadas por orden del titular del Ministerio para la Transición Ecológica previo acuerdo de la Comisión Delegada del Gobierno para Asuntos Económicos.

Estas orientaciones podrán adoptarse en relación con las Circulares de carácter normativo en materia energética que la Comisión Nacional de los Mercados y la Competencia tenga previsto aprobar y que puedan incidir sobre aspectos y prioridades de política energética en los que el Gobierno ostente la competencia. En concreto, las orientaciones de política energética, de conformidad con lo dispuesto en el apartado 2 del artículo 1 citado, podrán referirse a aspectos tales como «la seguridad de suministro, la seguridad pública, la sostenibilidad económica y financiera de los sistemas eléctrico y gasista, la independencia del suministro, la calidad del aire, la lucha contra el cambio climático y respeto al medio ambiente, la gestión óptima y el desarrollo de los recursos nacionales, la gestión de la demanda, la gestión de las elecciones tecnológicas futuras, la utilización racional de la energía, así como cualesquiera otros que guarden relación directa con las competencias del Gobierno en materia energética». Ello no obstante, este listado no tiene un carácter exhaustivo pues como señala el mismo apartado las orientaciones pueden abarcar cualquier aspecto que guarde relación directa con las competencias del Gobierno en materia energética.

La Disposición Transitoria primera del citado Real Decreto-ley 1/2019, de 11 de enero, establece que la Ministra para la Transición Ecológica podrá adoptar y remitir a la Comisión Nacional de los Mercados y la Competencia, con al menos un mes de antelación a la fecha prevista para el inicio de la tramitación, aquellas orientaciones de política energética que considere que dicha Comisión debe tener en cuenta en la regulación que contenga la circular de carácter normativo, y ello con objeto de asegurar la coherencia entre la actuación normativa de la Autoridad Reguladora y las prioridades de la política energética del Gobierno.

En aplicación de lo dispuesto en el apartado primero de la mencionada disposición transitoria, el pasado 14 de febrero de 2019 la Comisión Nacional de los Mercados y la Competencia ha comunicado al Ministerio para la Transición Ecológica un plan normativo a tramitar durante 2019, formado por trece circulares de carácter normativo, de las que seis se corresponden con el sector del gas natural, seis con el sector eléctrico y una con ambos sectores.

La Comisión Nacional de los Mercados y la Competencia prevé iniciar la tramitación de nueve de estas circulares el 30 de junio de 2019, mediante la audiencia de las propuestas, adoptándolas a lo largo del mes de octubre de 2019. En relación con las cuatro circulares restantes, más urgentes, prevé iniciar su tramitación el 30 de mayo de 2019 y que estén aprobadas el 15 de septiembre de 2019.

Considerando que varias de las circulares incluidas en el plan normativo notificado y cuya aprobación está prevista para el año 2019 afectan a aspectos y prioridades de política

ORIENTACIONES

CNMC

COMISIÓN NACIONAL DE LOS MERCADOS Y LA COMPETENCIA

Propuesta trámite audiencia

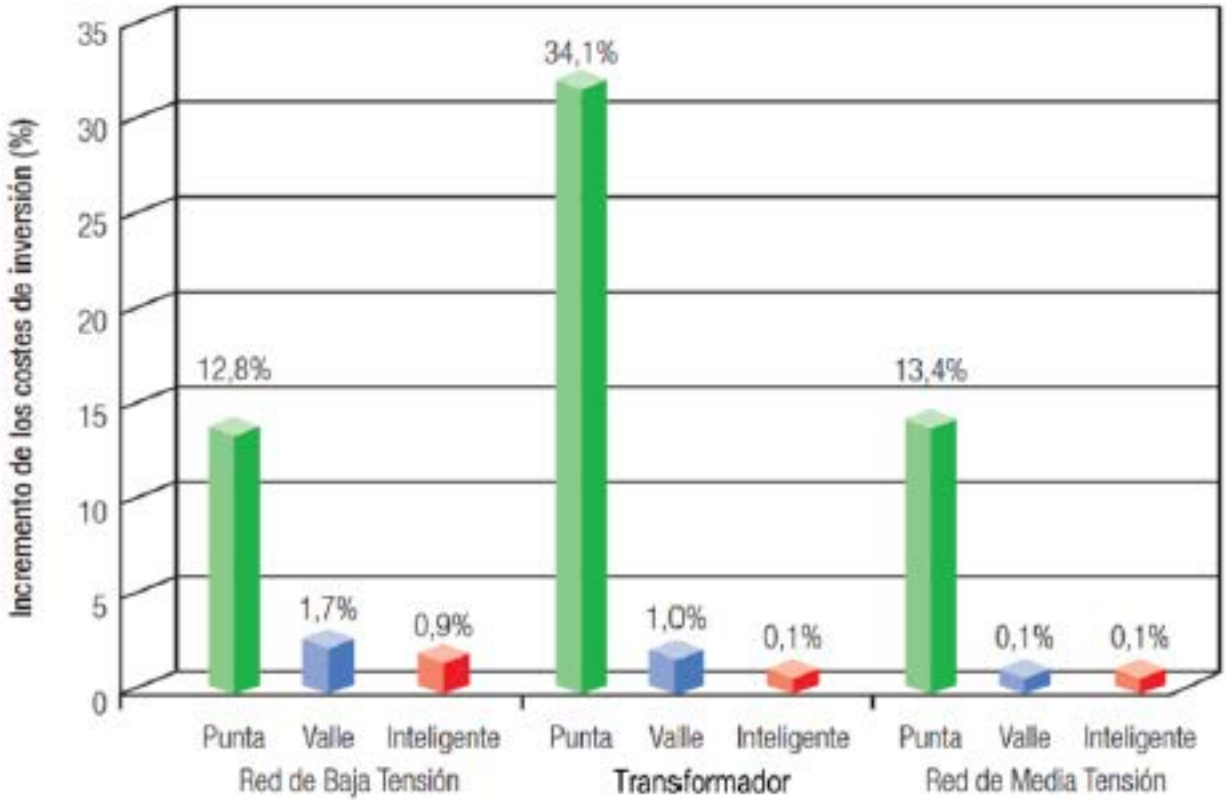
PROPUESTA DE CIRCULAR X/2019, DE XXX DE XXX, DE LA COMISIÓN NACIONAL DE LOS MERCADOS Y LA COMPETENCIA, POR LA QUE SE ESTABLECE LA METODOLOGÍA Y CONDICIONES DEL ACCESO Y DE LA CONEXIÓN A LAS REDES DE TRANSPORTE Y DISTRIBUCIÓN DE LAS INSTALACIONES DE PRODUCCIÓN DE ENERGÍA ELÉCTRICA.

El derecho de acceso de terceros a las redes de transporte y distribución constituye uno de los principios rectores de la liberalización del mercado de la electricidad: así lo ha confirmado la normativa sectorial española y el acervo de la Unión Europea.

PROPUESTA DE CIRCULAR DE CNMC

Let’s do it one step at a time…

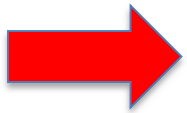
- Reflect **time differentiation** in the energy charges



-Impacto en la red eléctrica de distintos modos de recarga: inteligente (azul y rojo) frente a una recarga a demanda (verde). Fuente: (Frías et al, 2011)

Let's do it one step at a time…

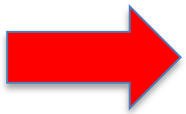
- Reflect **time differentiation** in the energy charges



Apply forward-looking **peak-coincident capacity charges** for networks & firm generation capacity *(if this is the case)*

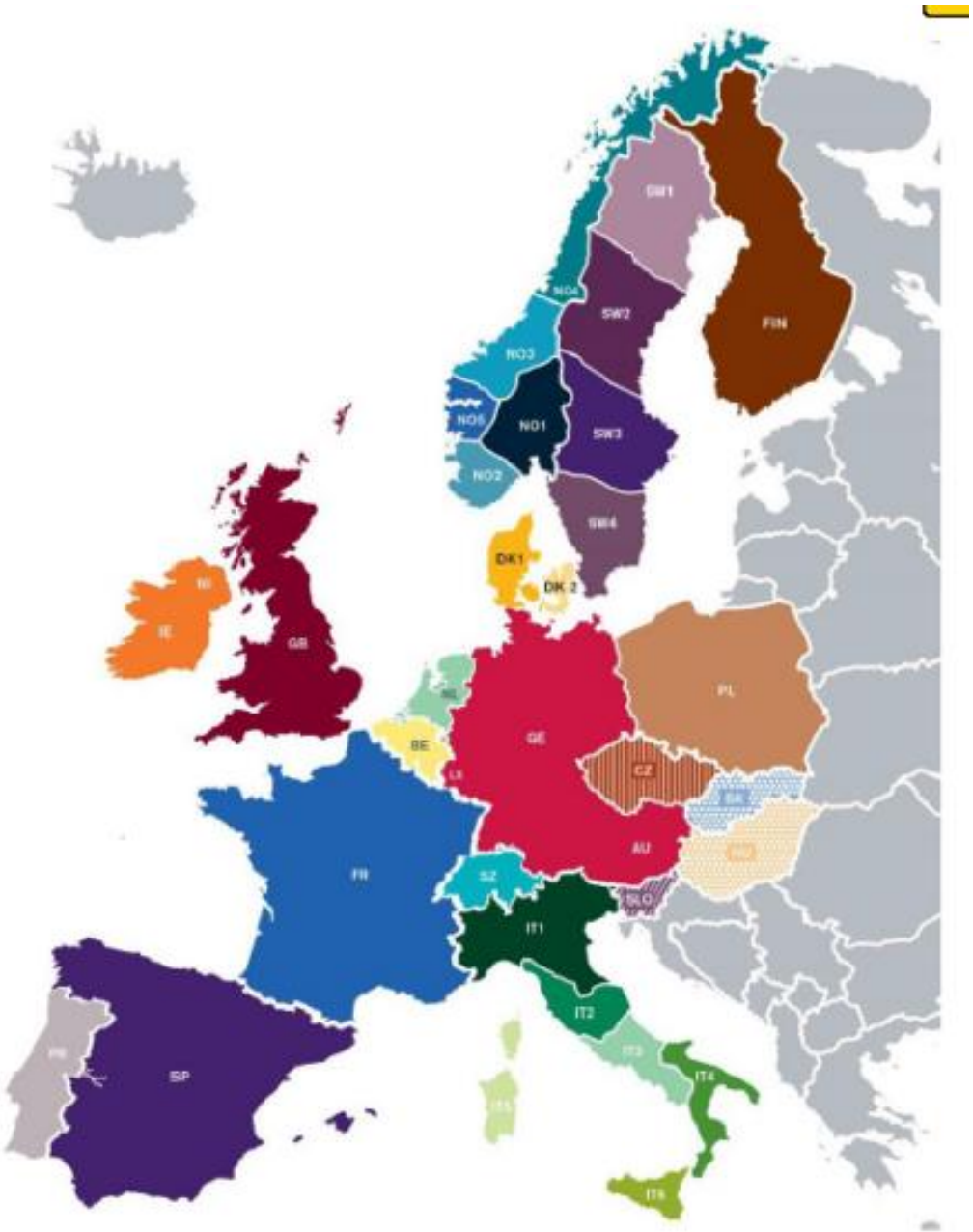
Let's do it one step at a time…

- Reflect **time differentiation** in the energy charges
- Apply forward-looking **peak-coincident capacity charges** for networks & firm generation capacity *(if this is the case)*

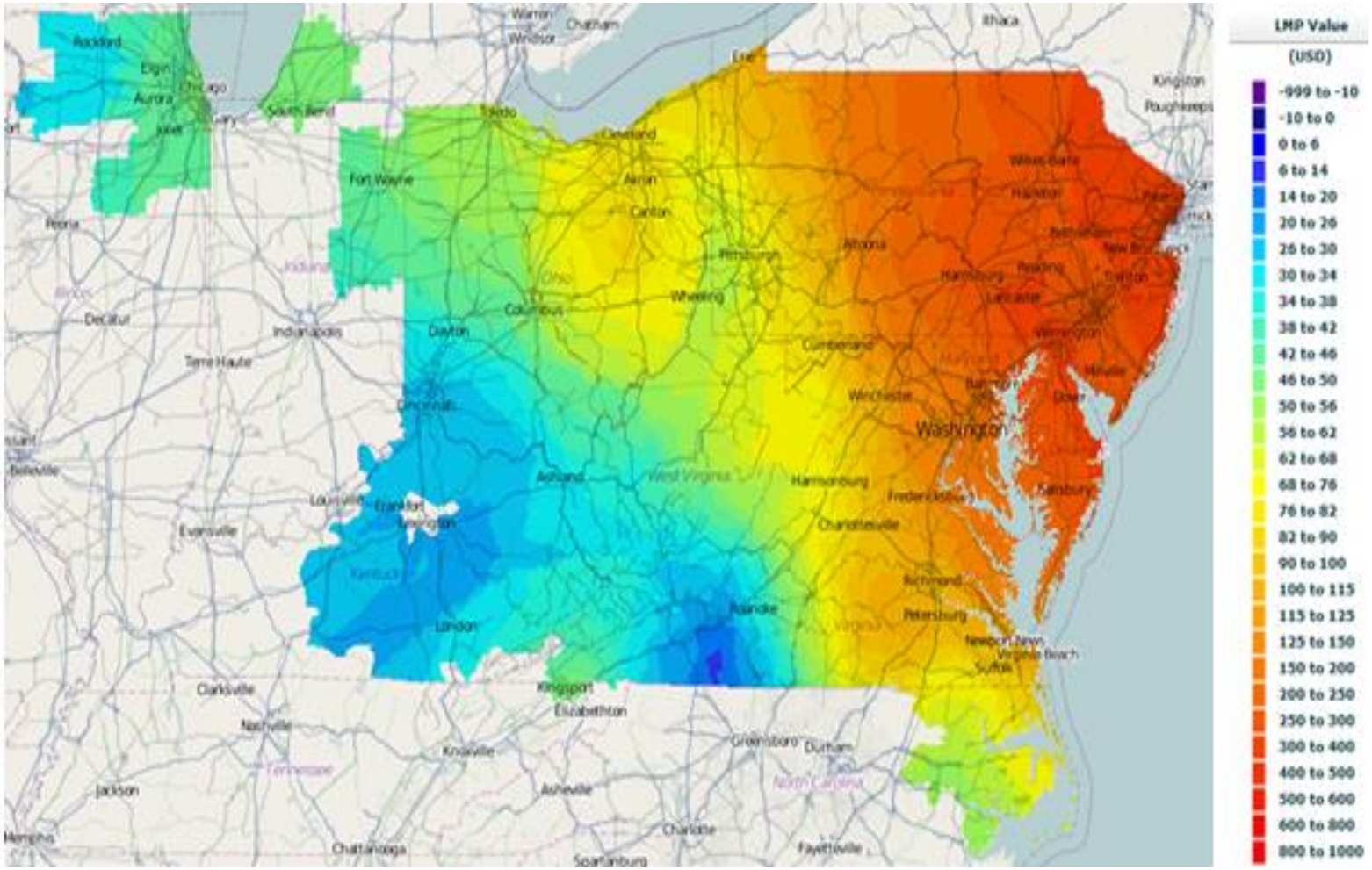


Progressively increase the **locational component** of prices & charges

Bidding zones in European market coupling

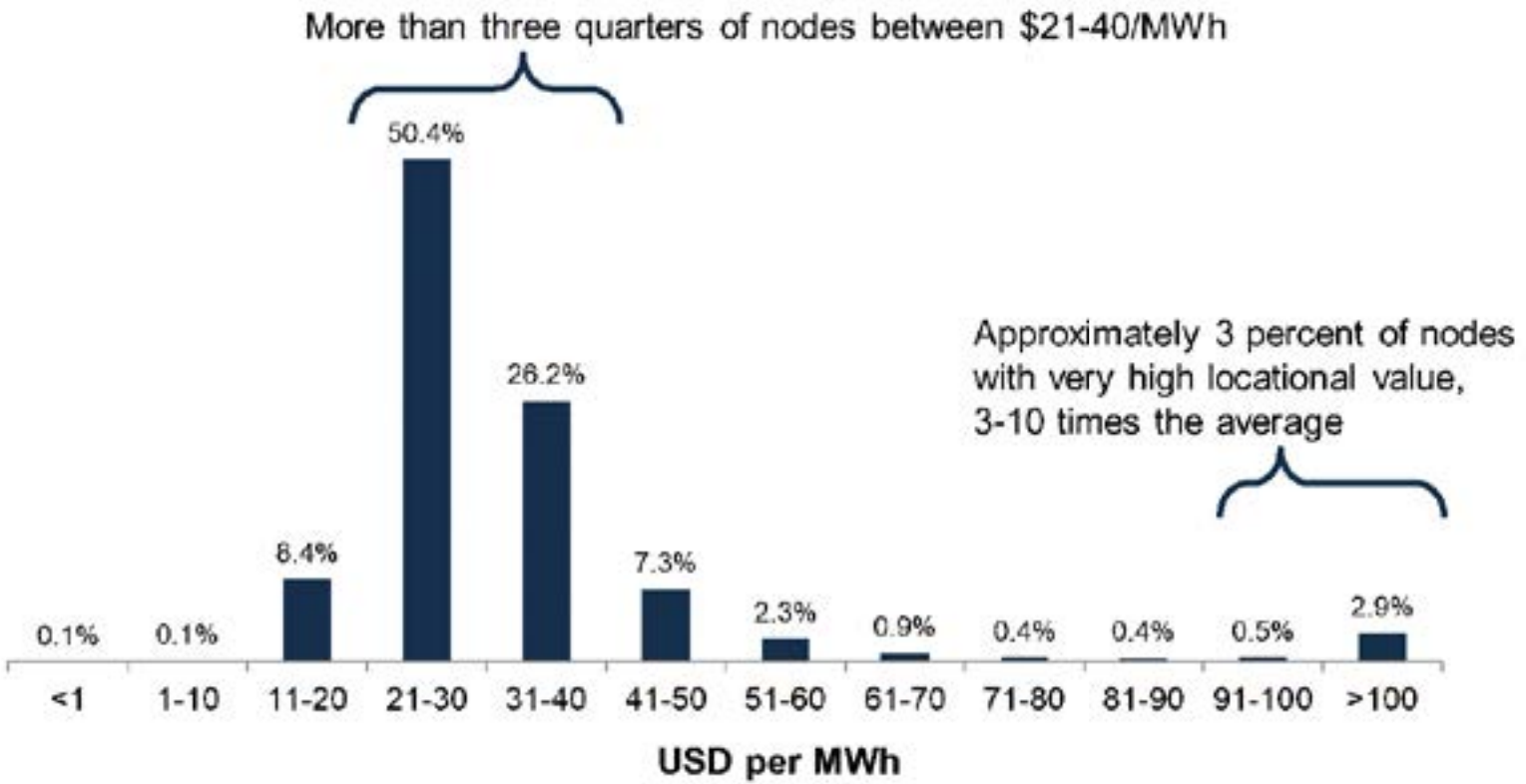


Energy prices at transmission level may vary significantly if there are binding network constraints



Wholesale LMP variation across more than 11,000 PJM nodes on July 19, 2015, at 4:05 pm

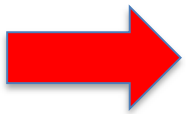
The value of energy can vary by orders of magnitude within a system, providing opportunities for DERs



Source: Burger et al., 2019. Why distributed? A critical review of the tradeoffs between centralized and decentralized resources. *IEEE Power and Energy Magazine*.

Let's do it one step at a time…

- Reflect **time differentiation** in the energy charges
- Apply forward-looking **peak-coincident capacity charges** for networks & firm generation capacity *(if this is the case)*
- Progressively increase the **locational component** of prices & charges



Policy & residual network costs should be charged **minimizing distortion** of cost-reflective signals

Policy costs & residual network costs **should not be recovered with volumetric charges** ($/kWh). We recommend a **fixed annual charge** distributed in monthly installments.

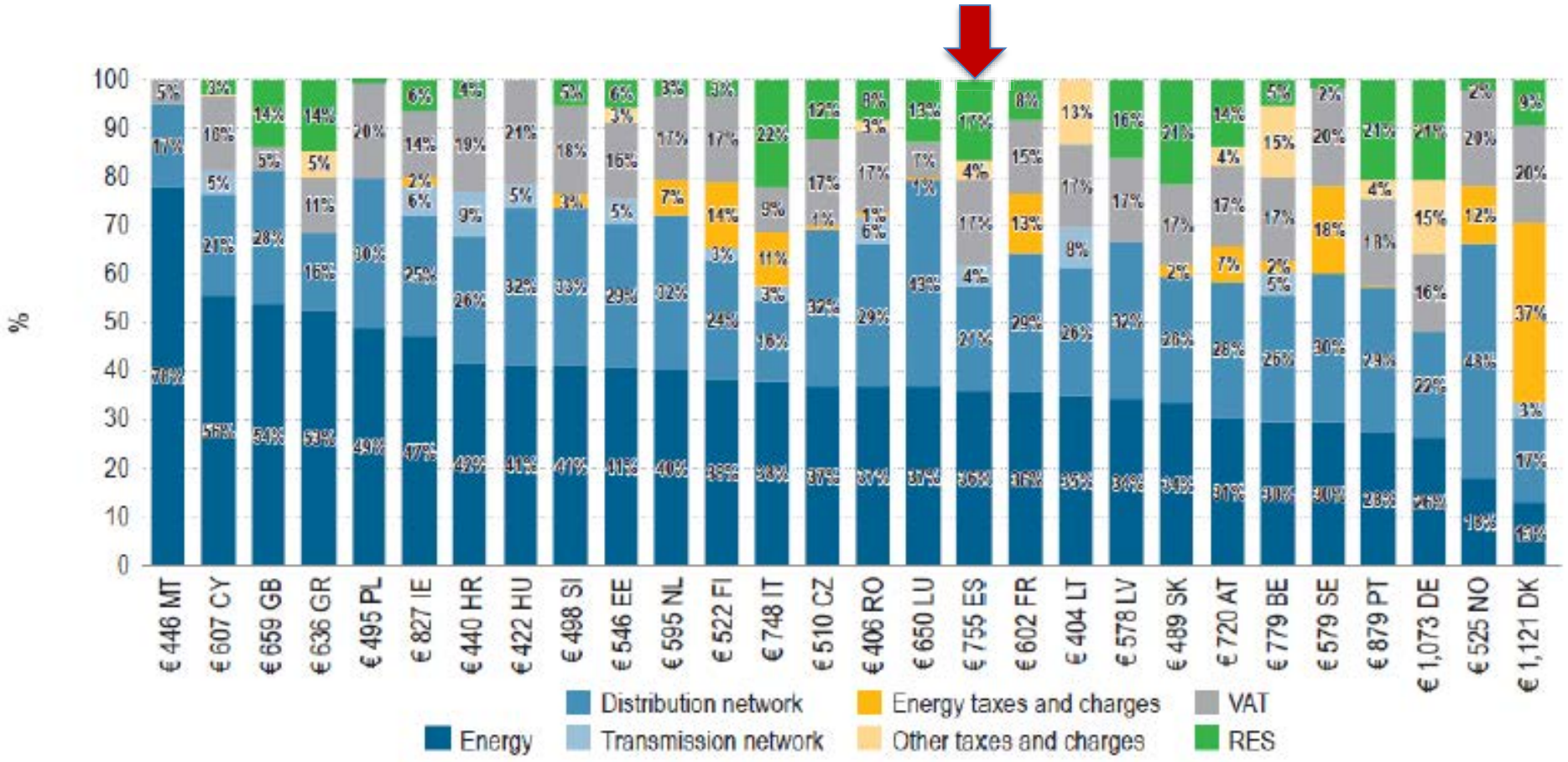
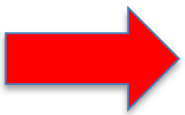


Figura 7-1.- *Descomposición de precios finales de electricidad para consumidores residenciales en capitales de la Unión Europea, Noviembre-Diciembre 2016. Fuente: (ACER, 2017).*

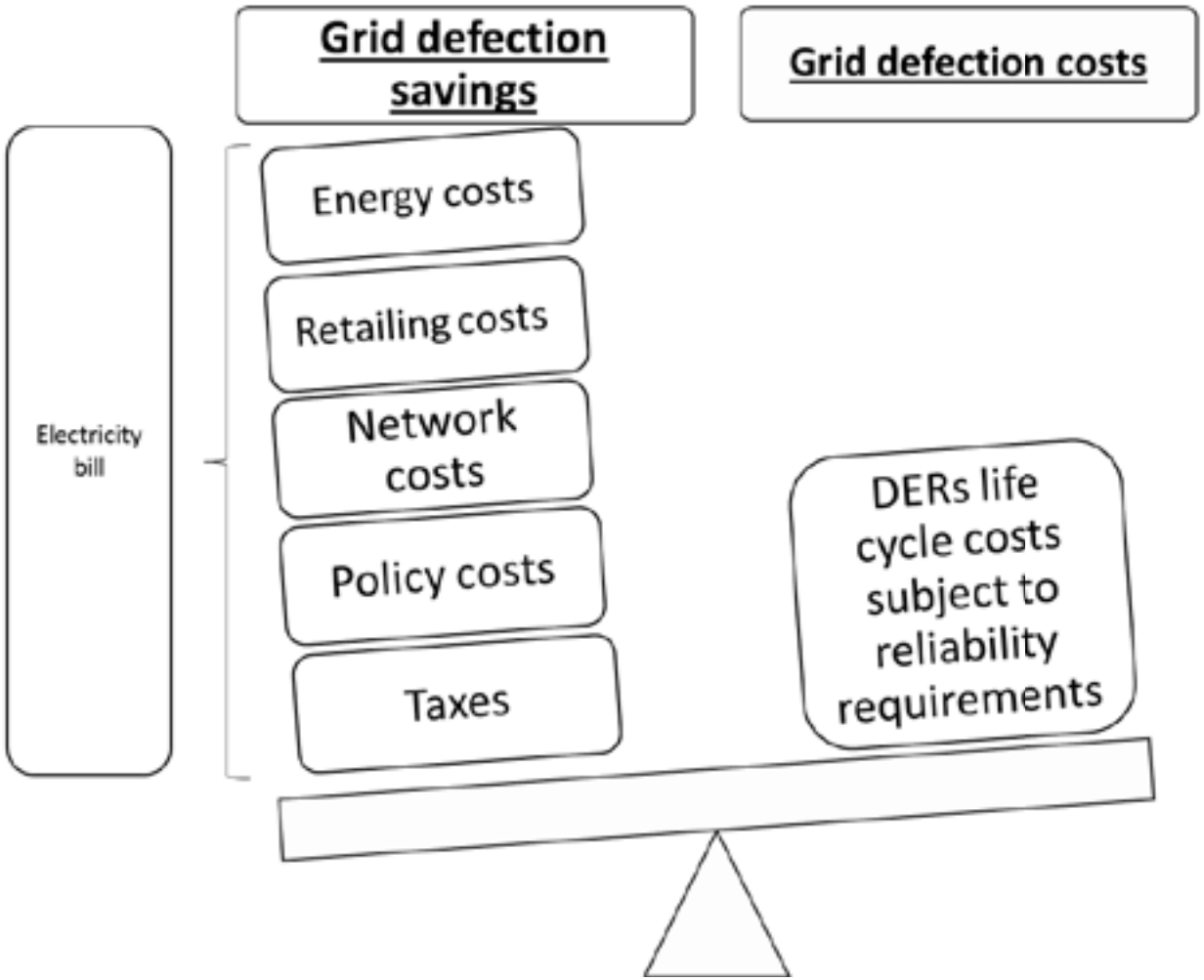
Let's do it one step at a time…

- Reflect **time differentiation** in the energy charges
- Apply forward-looking **peak-coincident capacity charges** for networks & firm generation capacity *(if this is the case)*
- Progressively increase the **locational component** of prices & charges
- **Policy & residual network costs** should be charged **minimizing distortion** of cost-reflective signals



Reconsider **which costs are included** in the electricity tariff if inefficient **grid defection** is a serious threat

Depending on the seriousness of the **threat of grid defection**, which costs are included in the electricity tariff must be carefully considered



Escuela Técnica Superior de Ingeniería (ICAI)
Instituto de Investigación Tecnológica

El Sector Eléctrico Español del Futuro: Retos y Políticas

Versión Final

Autores: Pedro Linares, Pablo Rodilla, Tomás Gómez, Michel Rivier, Pablo Frías, José Pablo Chaves, Álvaro Sánchez, Timo Gerres, Rafael Cossent, Luis Olmos, Andrés Ramos, Luis Rouco, Francisco Martín

Diciembre de 2018

Instituto de Investigación Tecnológica,
Universidad Pontificia Comillas,
Calle Santa Cruz de Marcenado 26, 28015 Madrid, España
+34 91 542 2800

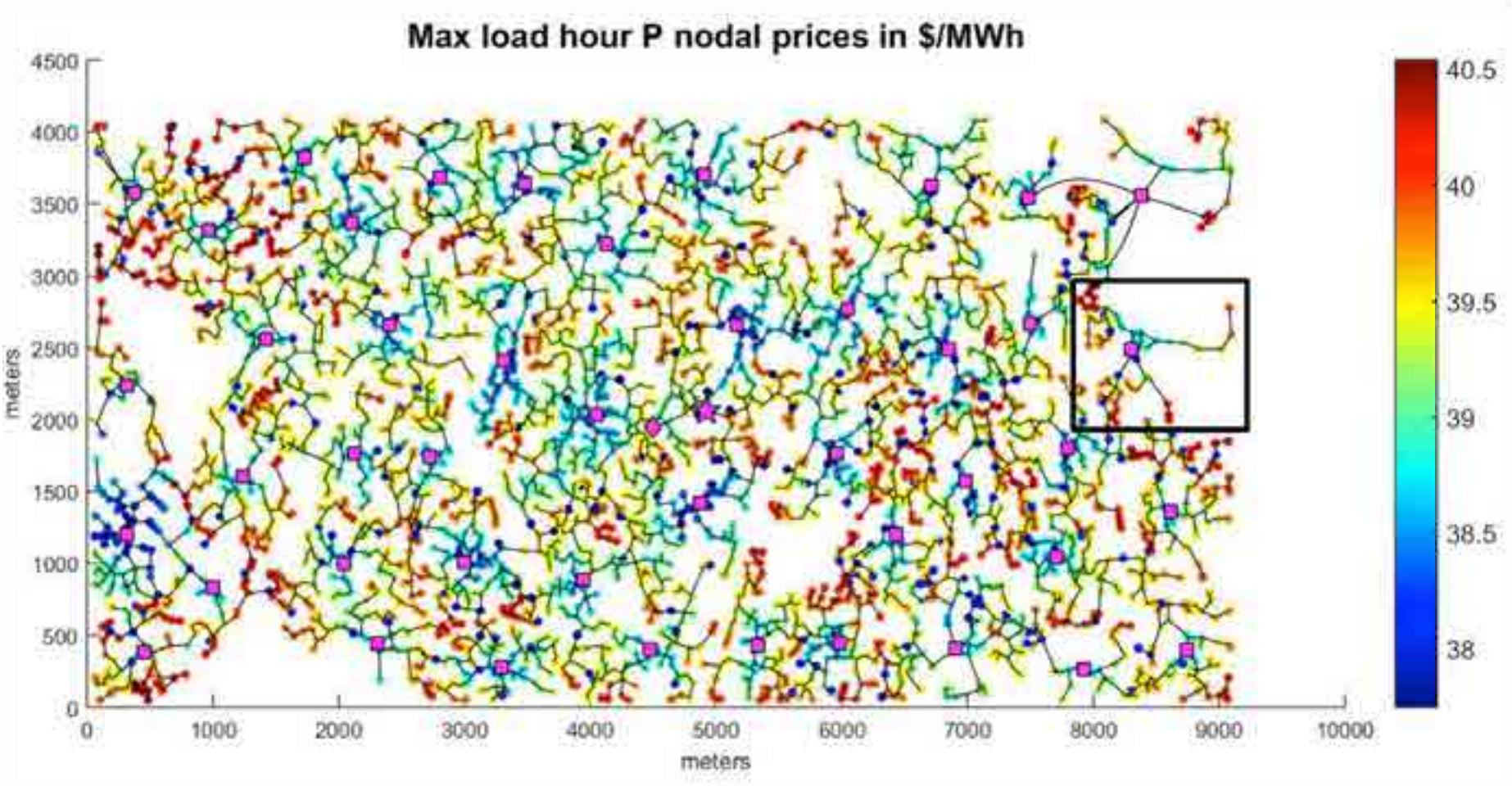
i) los precios cargados por kWh deben reflejar los costes marginales de generar y transportar la energía, por tanto deben ser simétricos para la energía inyectada o consumida, deben cambiar en el tiempo y depender del punto de conexión al sistema,

ii) los costes incrementales de redes deben cargarse de forma proporcional a la contribución de los usuarios en los períodos de máxima utilización de las mismas,

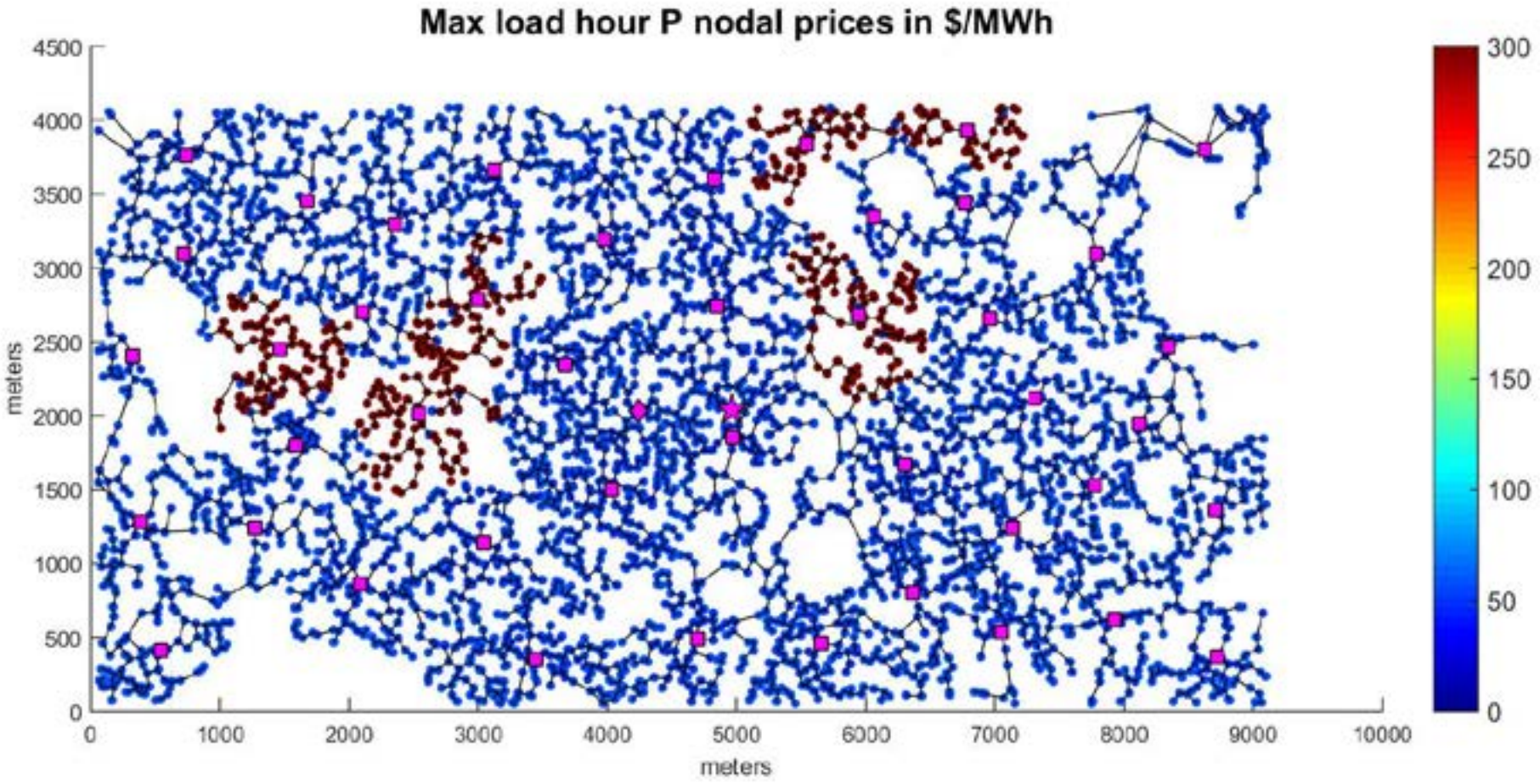
iii) los costes residuales de redes y otros cargos no directamente vinculados al consumo o generación de electricidad deben ser asignados de forma que distorsionen lo menos posible las señales eficientes de precio y de peajes de uso de redes, y

iv) se deben eliminar de la factura eléctrica aquellos cargos de política energética o políticas sociales, que distorsionen la competencia entre combustibles para usos finales energéticos, o que induzcan a prácticas ineficientes de desconexión de la red para evitar pagar la elevada factura eléctrica.

Getting deep into distribution
(just losses)



Getting deep into distribution
(losses & network constraints)



Rate Design for the 21st Century: Improving Economic Efficiency and Distributional Equity in Electricity Rate Design

by

Scott P. Burger

B.S., Washington University in St. Louis (2011)
S.M., Massachusetts Institute of Technology (2015)

Submitted to the Institute for Data, Systems, and Society
in partial fulfillment of the requirements for the degree of

Doctor of Philosophy in Engineering Systems

at the

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

September 2019

Author .....
Institute for Data, Systems, and Society
July 13, 2019

Certified by .....
Ignacio J. Pérez-Arriaga
Visiting Professor, Sloan School of Management
Professor, Electrical Engineering, Comillas University
Thesis Supervisor

Accepted by .....
Munther Dahleh
William A. Coolidge Professor, Electrical Engineering and Computer Science

Distributional Effects of Residential Electricity Tariff Design

1. Any transition to new tariffs creates winners and losers.
2. Moving volumetric components towards more time-varying prices benefits low-income customers.
3. Transitioning to higher fixed charges causes higher average expenditures for low-income customers on average.
4. Differentiating fixed charges according to customer criteria can mitigate some or all of the undesirable distributional impacts while maintaining the desired economic efficiency benefits

2

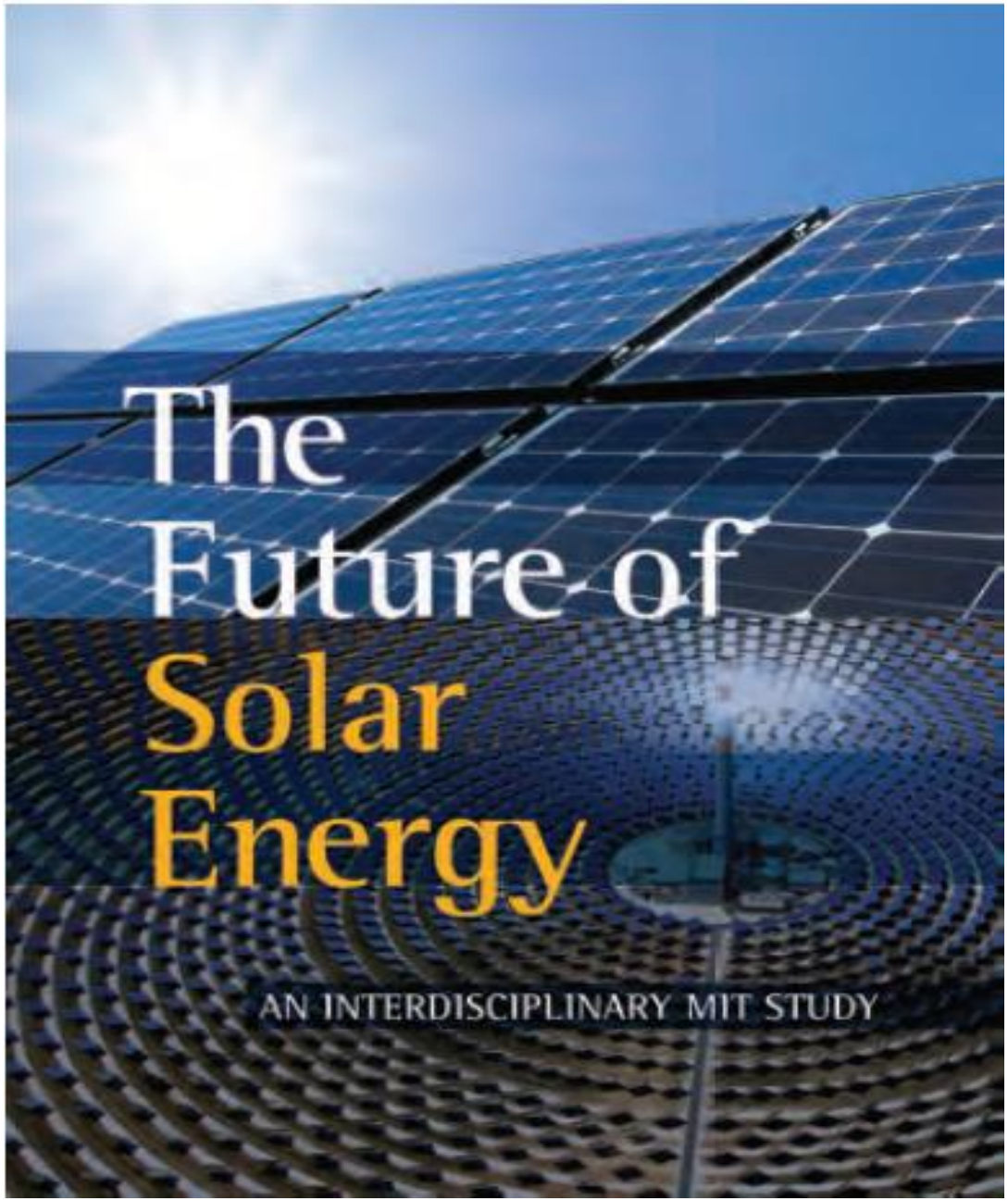
"Enhance distribution regulation"

The **regulation of distribution utilities must be improved** to enable the development of more efficient & innovative distribution utility business models

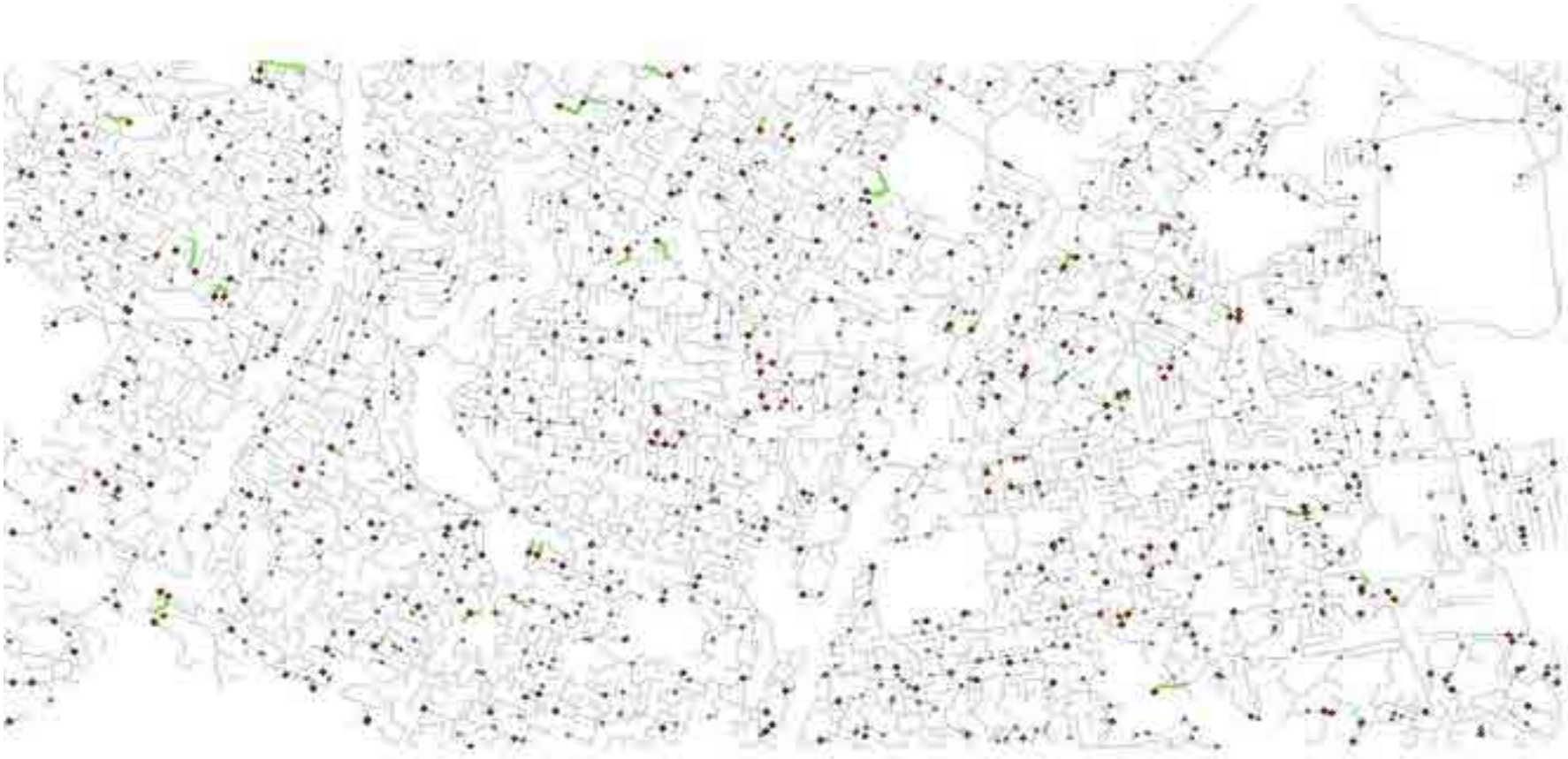
Reforming utility incentives will drive utilities to engage customers in cost-saving DER opportunities

Improve distribution regulation by:

1) Incentivizing utilities to pursue cost-saving DER opportunities
2) Allowing utilities to recover the costs of contracts with 3rd party DER providers.


The Future of Solar Energy
AN INTERDISCIPLINARY MIT STUDY

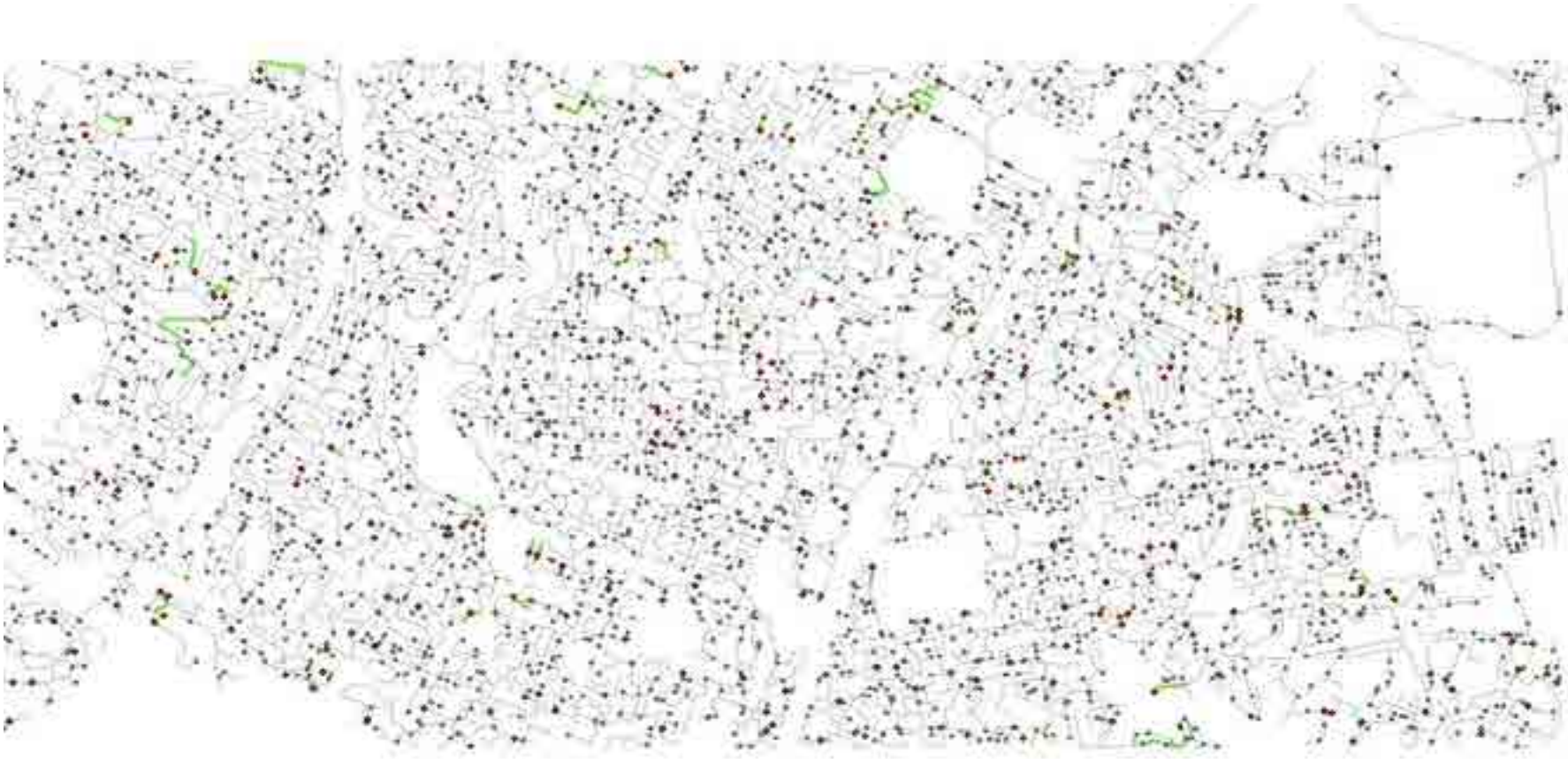
Reference Network Model



Source: MIT Solar Study

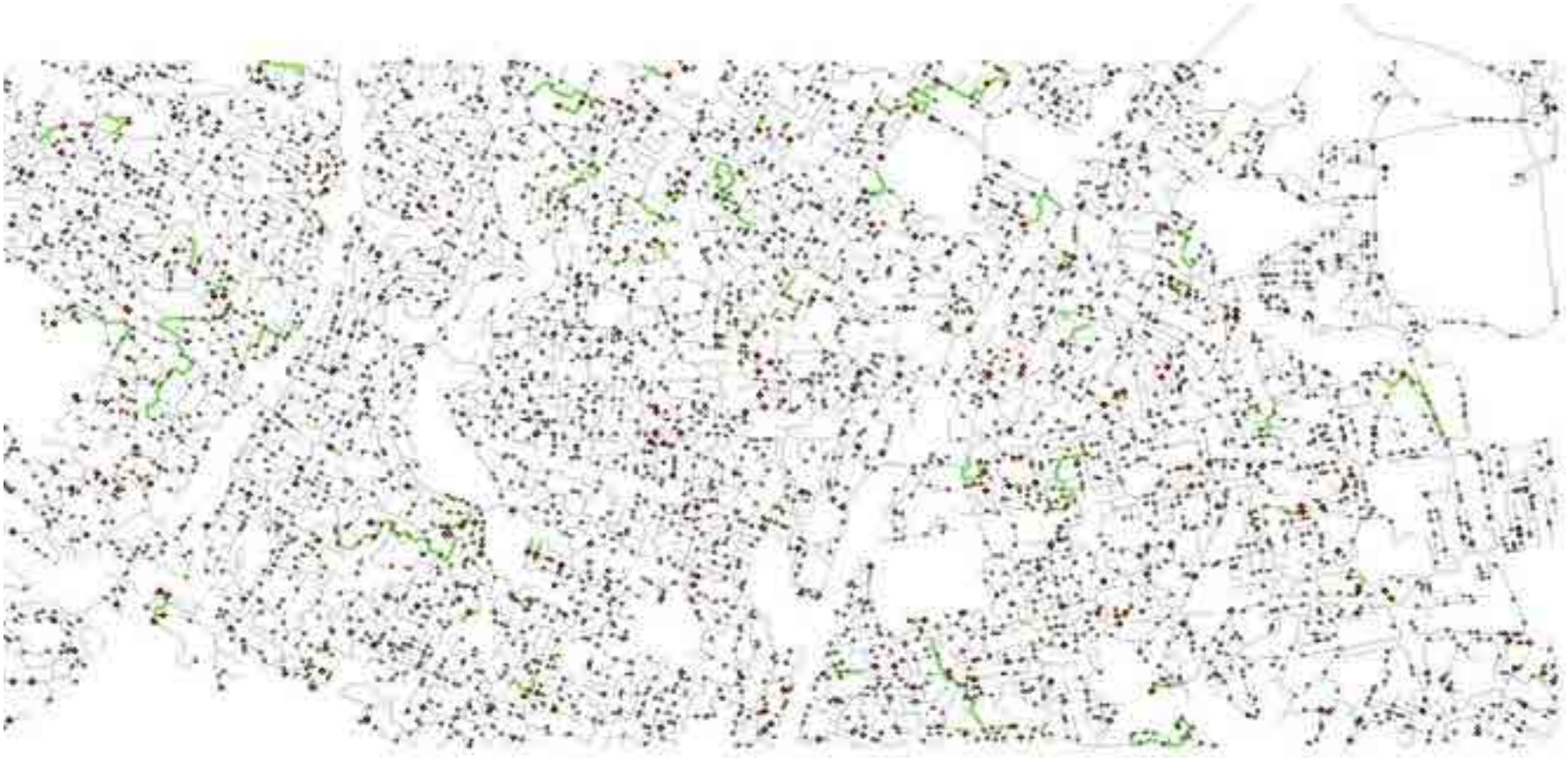
(*) Model RNM developed by IIT-Comillas University

Reference Network Model



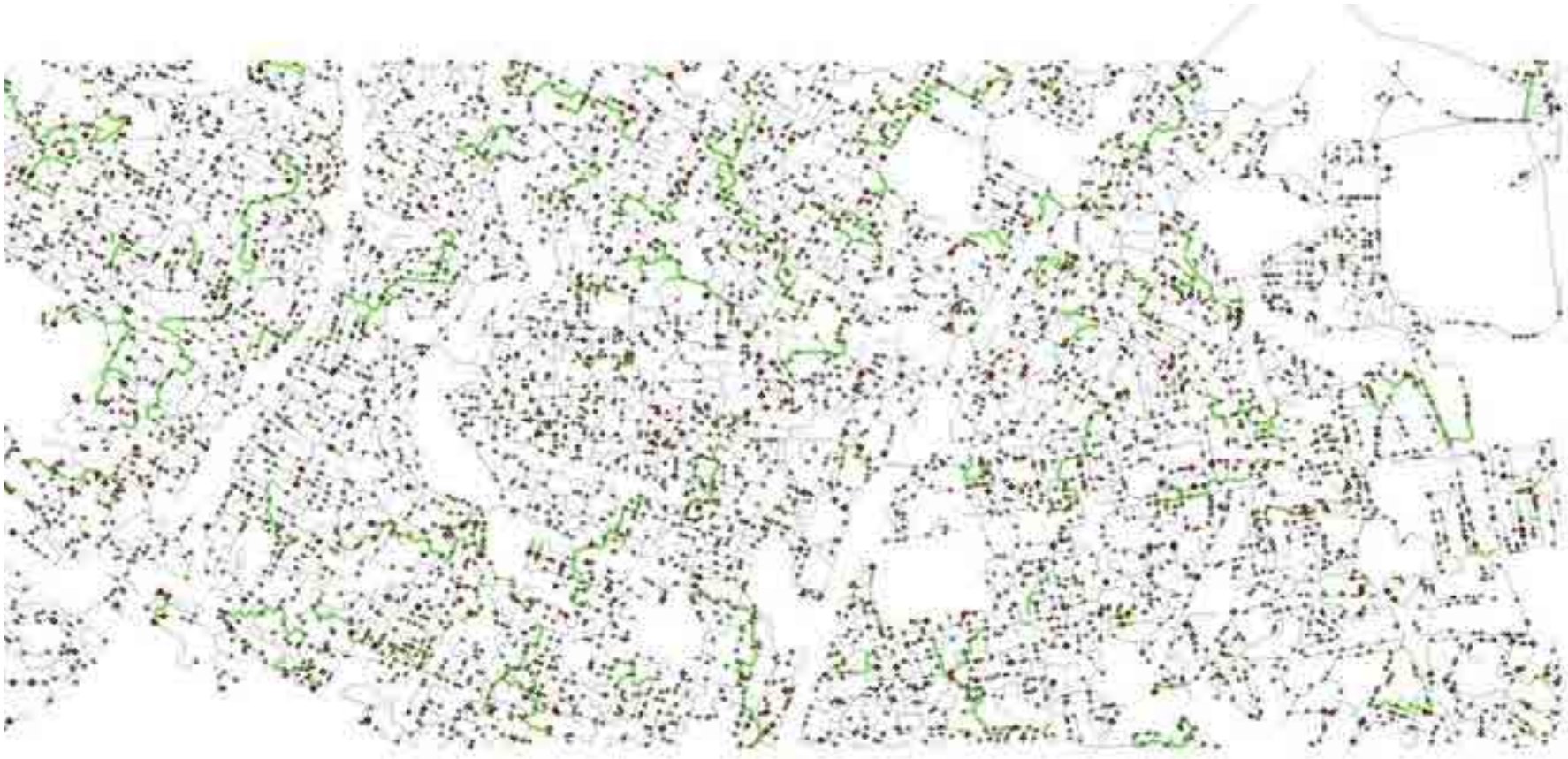
Source: MIT Solar Study

Reference Network Model



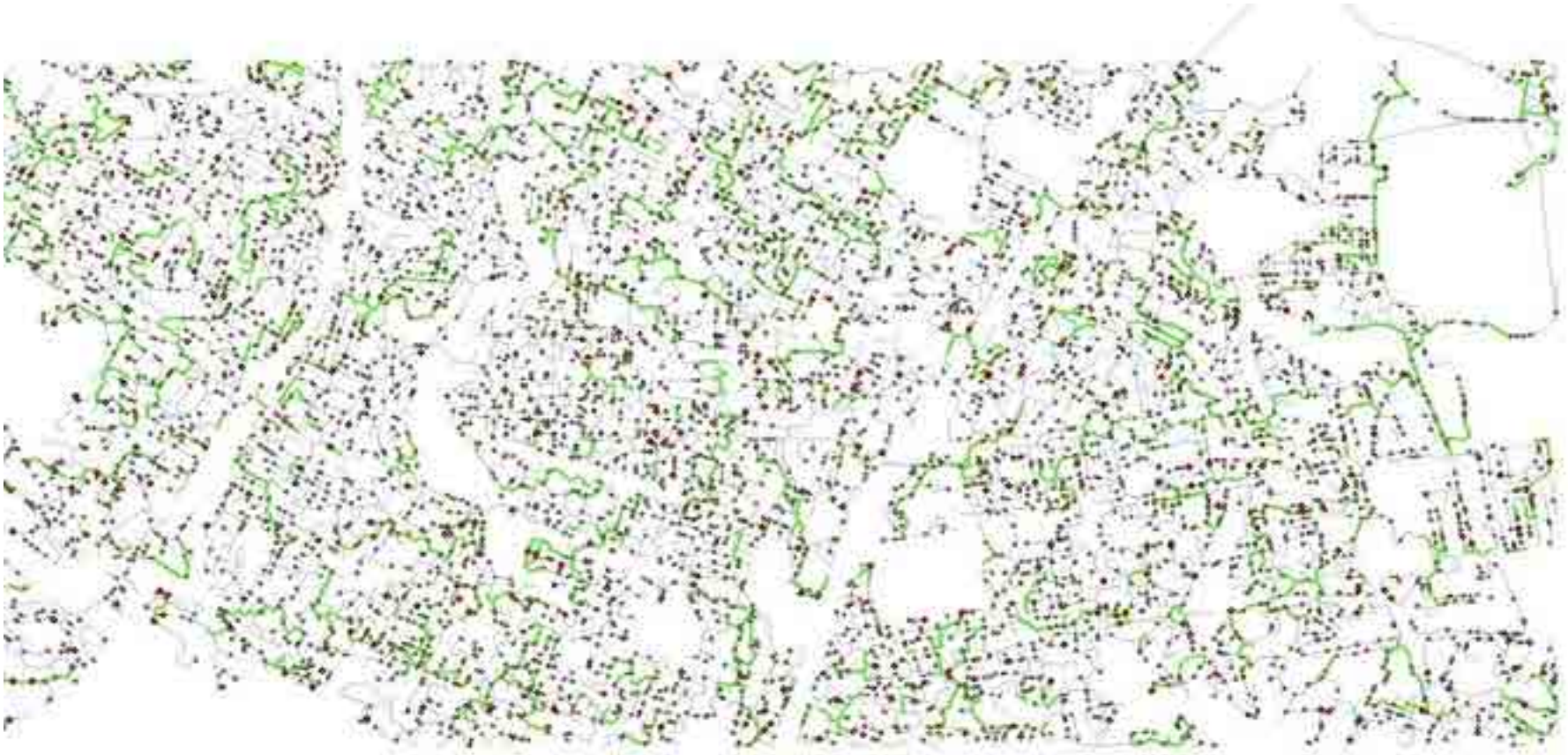
Source: MIT Solar Study

Reference Network Model



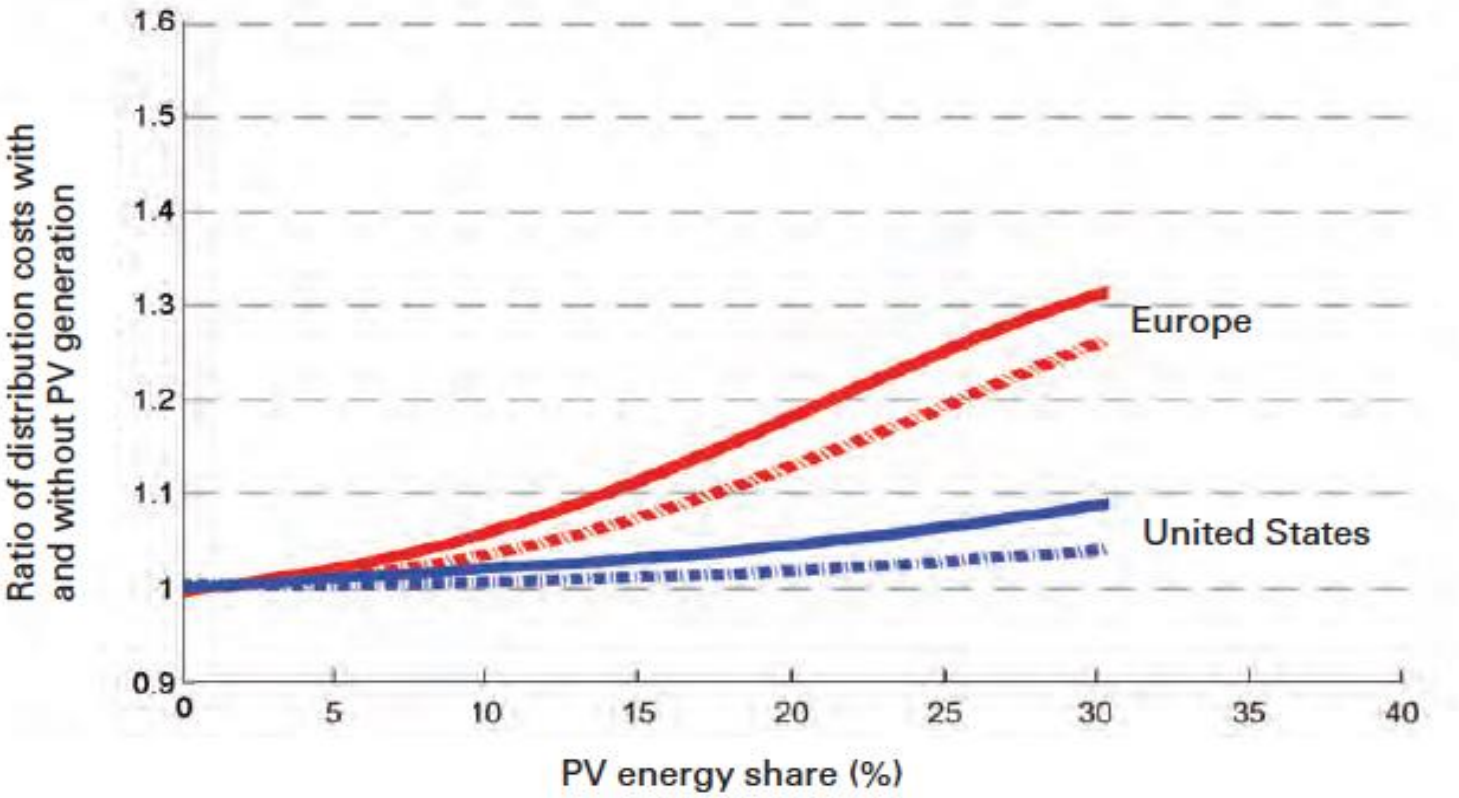
Source: MIT Solar Study

Reference Network Model



Source: MIT Solar Study

Changes in network costs with growing PV penetration



These curves show the impact of solar generation on distribution network costs in the United States (blue) and in Europe (red). (Results differ in part due to differing network configurations and voltages.) Costs are measured relative to the cost of a corresponding no-PV scenario. Energy storage is assumed to be unavailable. Solid lines indicate 80% residential, 15% commercial, and 5% industrial demand. Dashed lines indicate 15% residential, 80% commercial, and 5% industrial demand. In all cases, costs increase as PV energy share increases, with the greater impact seen when residential customers dominate demand.

I. DISPOSICIONES GENERALES

MINISTERIO PARA LA TRANSICIÓN ECOLÓGICA

5244 *Orden TEC/406/2019, de 5 de abril, por la que se establecen orientaciones de política energética a la Comisión Nacional de los Mercados y la Competencia.*

El artículo 1 del Real Decreto-ley 1/2019, de 11 de enero, de medidas urgentes para adecuar las competencias de la Comisión Nacional de los Mercados y la Competencia a las exigencias derivadas del derecho comunitario en relación a las Directivas 2009/72/CE y 2009/73/CE del Parlamento Europeo y del Consejo, de 13 de julio de 2009, sobre normas comunes para el mercado interior de la electricidad y del gas natural, establece en su apartado primero que la Comisión Nacional de los Mercados y la Competencia, en el ámbito de sus competencias de regulación, deberá tener en consideración las prioridades estratégicas establecidas por el Gobierno, que se materializarán en unas orientaciones de política energética adoptadas por orden del titular del Ministerio para la Transición Ecológica previo acuerdo de la Comisión Delegada del Gobierno para Asuntos Económicos.

Estas orientaciones podrán adoptarse en relación con las Circulares de carácter normativo en materia energética que la Comisión Nacional de los Mercados y la Competencia tenga previsto aprobar y que puedan incidir sobre aspectos y prioridades de política energética en los que el Gobierno ostente la competencia. En concreto, las orientaciones de política energética, de conformidad con lo dispuesto en el apartado 2 del artículo 1 citado, podrán referirse a aspectos tales como «la seguridad de suministro, la seguridad pública, la sostenibilidad económica y financiera de los sistemas eléctrico y gasista, la independencia del suministro, la calidad del aire, la lucha contra el cambio climático y respeto al medio ambiente, la gestión óptima y el desarrollo de los recursos nacionales, la gestión de la demanda, la gestión de las elecciones tecnológicas futuras, la utilización racional de la energía, así como cualesquiera otros que guarden relación directa con las competencias del Gobierno en materia energética». Ello no obstante, este listado no tiene un carácter exhaustivo pues como señala el mismo apartado las orientaciones pueden abarcar cualquier aspecto que guarde relación directa con las competencias del Gobierno en materia energética.

La Disposición Transitoria primera del citado Real Decreto-ley 1/2019, de 11 de enero, establece que la Ministra para la Transición Ecológica podrá adoptar y remitir a la Comisión Nacional de los Mercados y la Competencia, con al menos un mes de antelación a la fecha prevista para el inicio de la tramitación, aquellas orientaciones de política energética que considere que dicha Comisión debe tener en cuenta en la regulación que contenga la circular de carácter normativo, y ello con objeto de asegurar la coherencia entre la actuación normativa de la Autoridad Reguladora y las prioridades de la política energética del Gobierno.

En aplicación de lo dispuesto en el apartado primero de la mencionada disposición transitoria, el pasado 14 de febrero de 2019 la Comisión Nacional de los Mercados y la Competencia ha comunicado al Ministerio para la Transición Ecológica un plan normativo a tramitar durante 2019, formado por trece circulares de carácter normativo, de las que seis se corresponden con el sector del gas natural, seis con el sector eléctrico y una con ambos sectores.

La Comisión Nacional de los Mercados y la Competencia prevé iniciar la tramitación de nueve de estas circulares el 30 de junio de 2019, mediante la audiencia de las propuestas, adoptándolas a lo largo del mes de octubre de 2019. En relación con las cuatro circulares restantes, más urgentes, prevé iniciar su tramitación el 30 de mayo de 2019 y que estén aprobadas el 15 de septiembre de 2019.

Considerando que varias de las circulares incluidas en el plan normativo notificado y cuya aprobación está prevista para el año 2019 afectan a aspectos y prioridades de política

ORIENTACIONES SOBRE LAS CIRCULARES

Séptimo. *Circular de metodología de retribución de la distribución de electricidad.*

1. Para asegurar la sostenibilidad del sistema eléctrico y la seguridad de suministro, la nueva metodología debería procurar que los cambios en la metodología que en su caso se introduzcan, vengan acompañados de mecanismos de absorción gradual de los mismos.

2. Con el objetivo de fomentar la penetración de las energías renovables en el sistema eléctrico y poder así cumplir los objetivos en materia de energía y clima, la metodología debería considerar adecuadamente las nuevas necesidades de inversiones que se derivarán de los planes aprobados por la Administración General del Estado, tanto en cuanto al volumen como en cuanto a su naturaleza (activos para la gestión inteligente de la red basados en tecnologías de la información y las comunicaciones).

3. La metodología de retribución debería incorporar un principio de prudencia financiera requerida a los titulares de activos de red.

4. La metodología de retribución debería incentivar la extensión del funcionamiento de aquellas instalaciones que hayan superado su vida útil retributiva, al objeto de contribuir a una gestión óptima de los recursos nacionales y bajo el principio de optimizar el retorno para los consumidores y mantener los activos ya construidos y amortizados en condiciones adecuadas de operación, evitándose su sustitución con un coste de reposición más elevado.

3

"Rethink industry structure to minimize conflicts of interest"

The **structure** of the electricity industry should be carefully evaluated to minimize potential conflicts of interest

Establish independence between the DSO & agents performing activities in markets and
if independence is legal or functional, apply significant regulatory oversight and transparent mechanisms to provide services

Council of the European Union

Brussels, 11 January 2019
(OR. en)

5076/19

Interinstitutional File:
2016/0380(COD)

ENER 3
ENV 5
CLIMA 2
COMPET 9
CONSOM 3
FISC 12
CODEC 17

NOTE

From:	General Secretariat of the Council
To:	Permanent Representatives Committee
No. Cion doc.:	15150/1/16 REV 1 + ADD 1 REV 1
Subject:	Proposal for a Directive of the European Parliament and of the Council on common rules for the internal market in electricity (recast) - Analysis of the final compromise text with a view to agreement

1. The sixth and final trilogue on the Directive on electricity was held on 18 December 2018, and a provisional agreement was reached on the basis of the text as reflected in Annex.

2. The Permanent Representatives Committee is thus invited to:

   - endorse the annexed compromise text as agreed in the trilogue, and
   - mandate the Presidency to inform the European Parliament that, should the European Parliament adopt its position at first reading, in accordance with Article 294 paragraph 3 of the Treaty, in the form set out in the compromise package contained in the Annex to this document (subject to revision by the legal linguists of both institutions), the Council would, in accordance with Article 294, paragraph 4 of the Treaty, approve the European Parliament's position and the act shall be adopted in the wording which corresponds to the European Parliament's position.

Council of the
European Union

Brussels, 11 January 2019
(OR. en)

5070/19

Interinstitutional File:
2016/0379(COD)

ENER 2
ENV 4
CLIMA 1
COMPET 8
CONSOM 2
FISC 11
CODEC 14

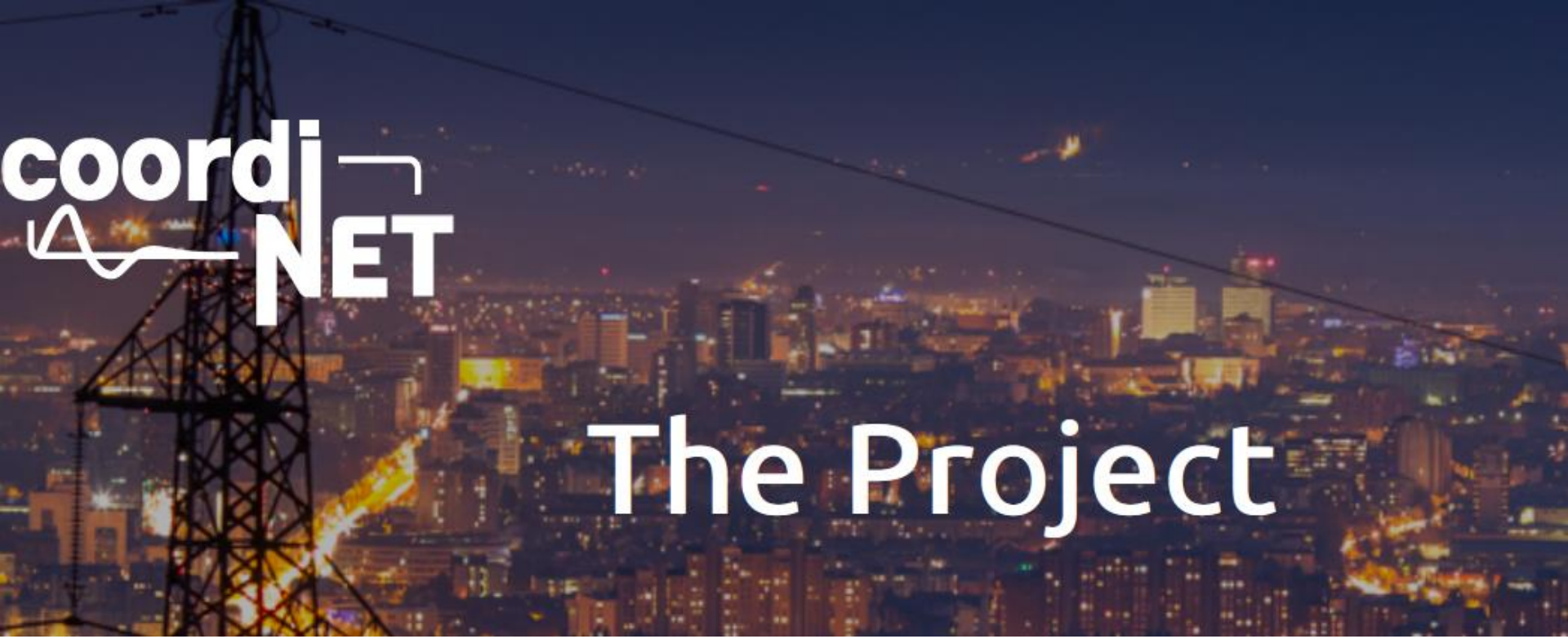
NOTE

From:	General Secretariat of the Council
To:	Permanent Representatives Committee
No. Cion doc.:	15135/1/16 REV 1 + ADD 1 REV 1 + ADD 2 REV 1
Subject:	Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the internal market for electricity (recast) - Analysis of the final compromise text with a view to agreement

1. The sixth and final trilogue on the Regulation on electricity was held on 18 December 2018, and a provisional agreement was reached on the basis of the text as reflected in Annex.

2. The Permanent Representatives Committee is thus invited to:

   - endorse the annexed compromise text as agreed in the trilogue, and
   - mandate the Presidency to inform the European Parliament that, should the European Parliament adopt its position at first reading, in accordance with Article 294 paragraph 3 of the Treaty, in the form set out in the compromise package contained in the Annex to this document (subject to revision by the legal linguists of both institutions), the Council would, in accordance with Article 294, paragraph 4 of the Treaty, approve the European Parliament's position and the act shall be adopted in the wording which corresponds to the European Parliament's position.



The Project

The CoordiNet project will help to demostrate how DSOs and TSOs shall act in a coordinated manner and use the same pool of resources to procure grid services in the most reliable and efficient way through the implementation of large scale "TSO-DSO-Consumer" demonstrations, in cooperation with market participants (and end users).

New formats of provision of services with economic value

A case example

Case example: enel x

#2 The role of DR aggregators: connect energy users to balance supply and demand

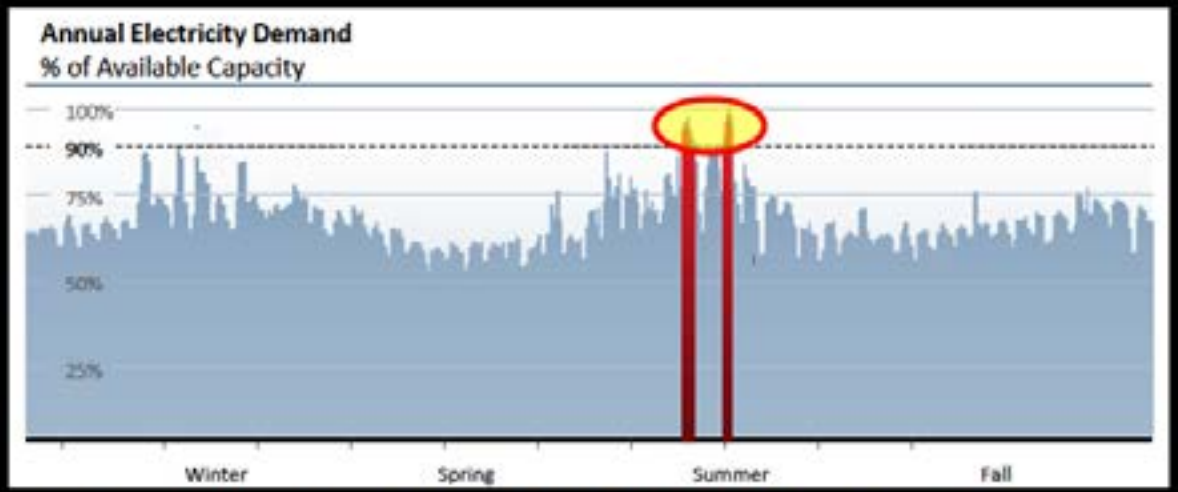
enel x

We create value for **C&I customers** by identifying and monetizing load flexibility (curtailment, distributed generation, storage)

We create value for **utilities** and **grid operators** by delivering cost efficient, reliable, and clean capacity and balancing resources

Case example: enel x

#2 DR works as an alternative to peaking generation and network investments



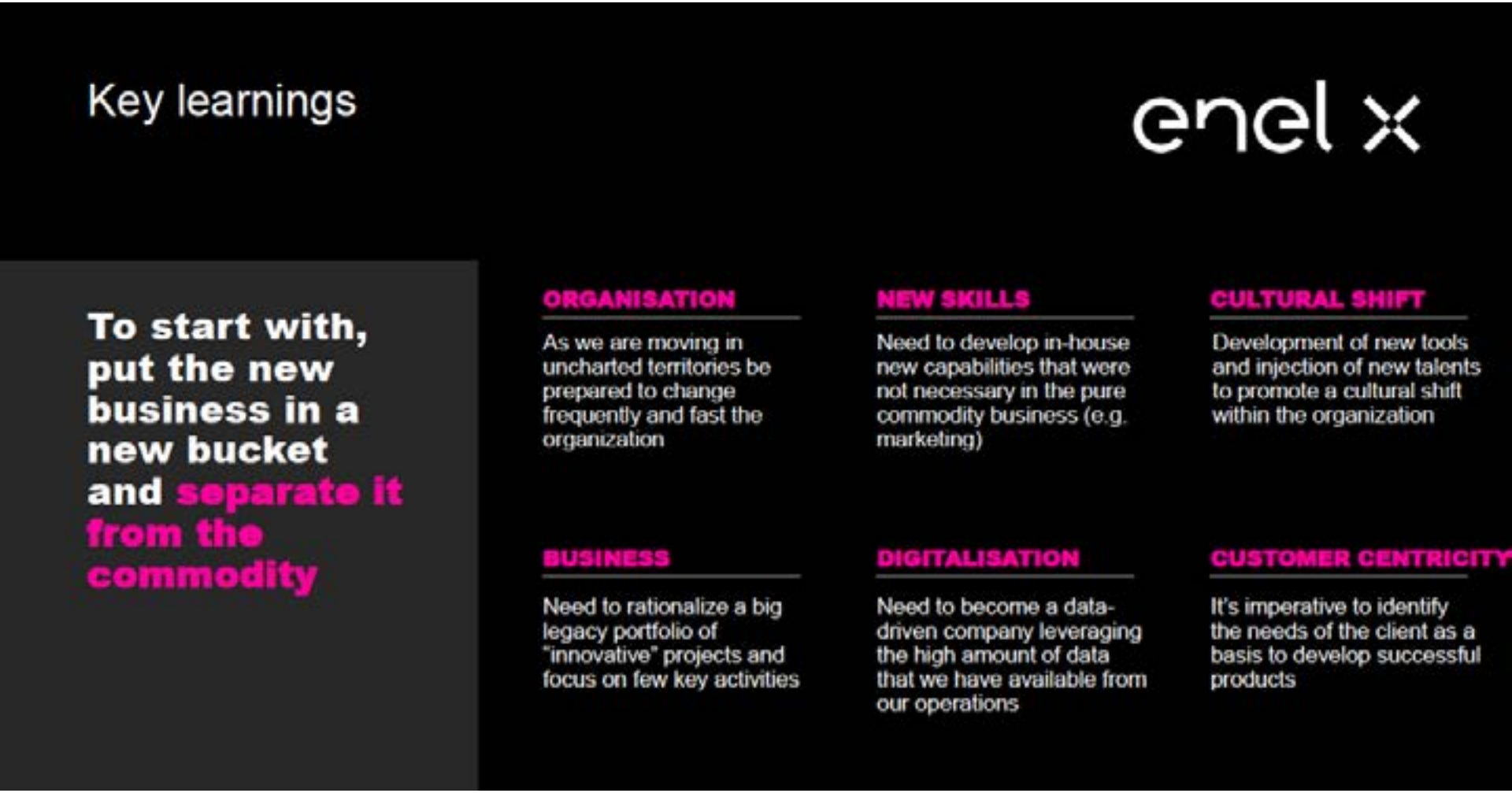
- DR is capital efficient: In typical system, >10% of infrastructure costs are spent to meet peak demand that occurs <1% of the time.
- DR is a dispatchable resource to address supercritical peaks and capacity shortages.

>$13 billion in proven savings from DR to PJM ratepayers in 2015/16*

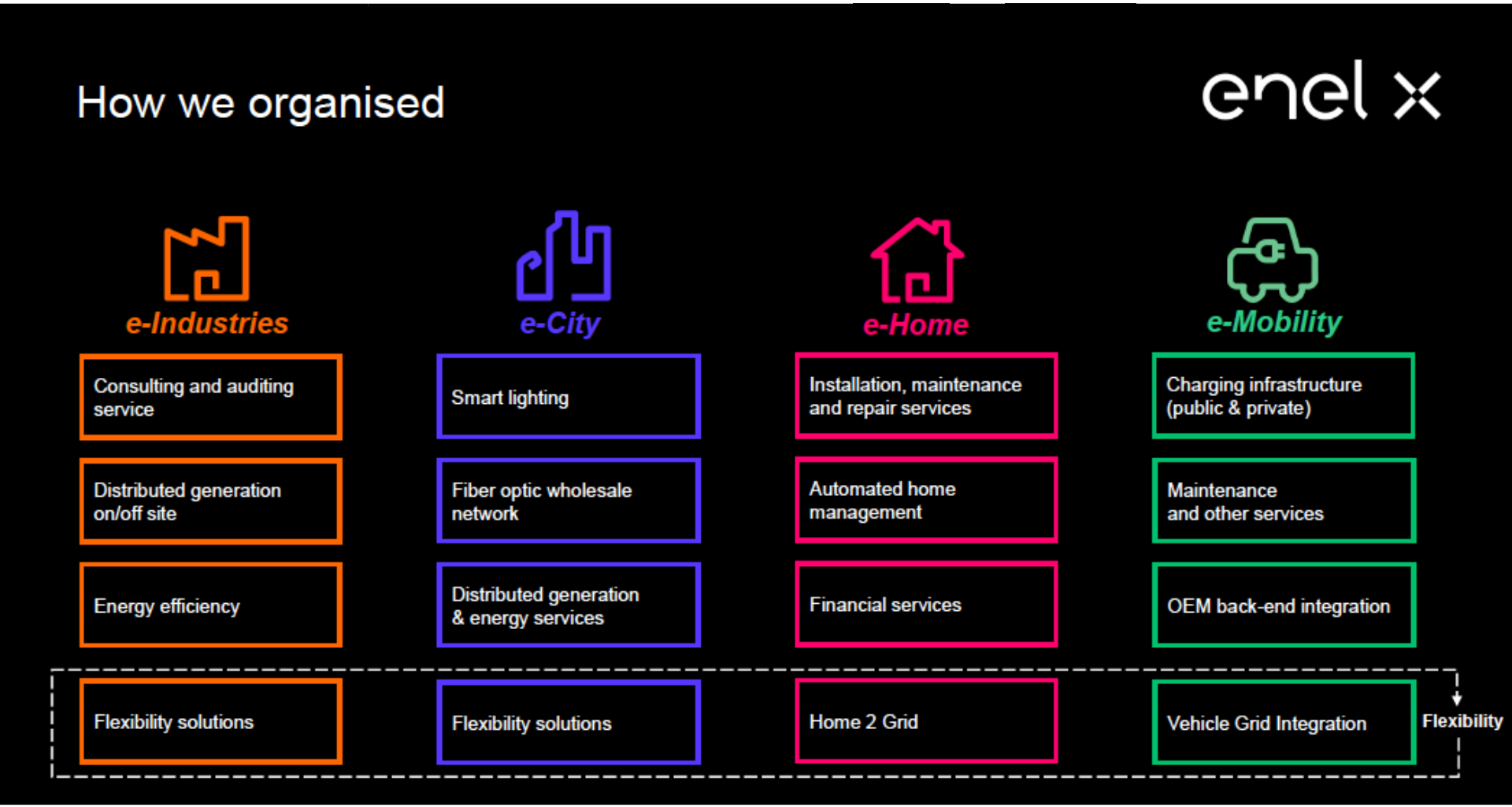
>$1 billion in savings delivered to C&I end-user customers by EnerNOC

GreenTech Media: "In many states… DR have become as important as generation"

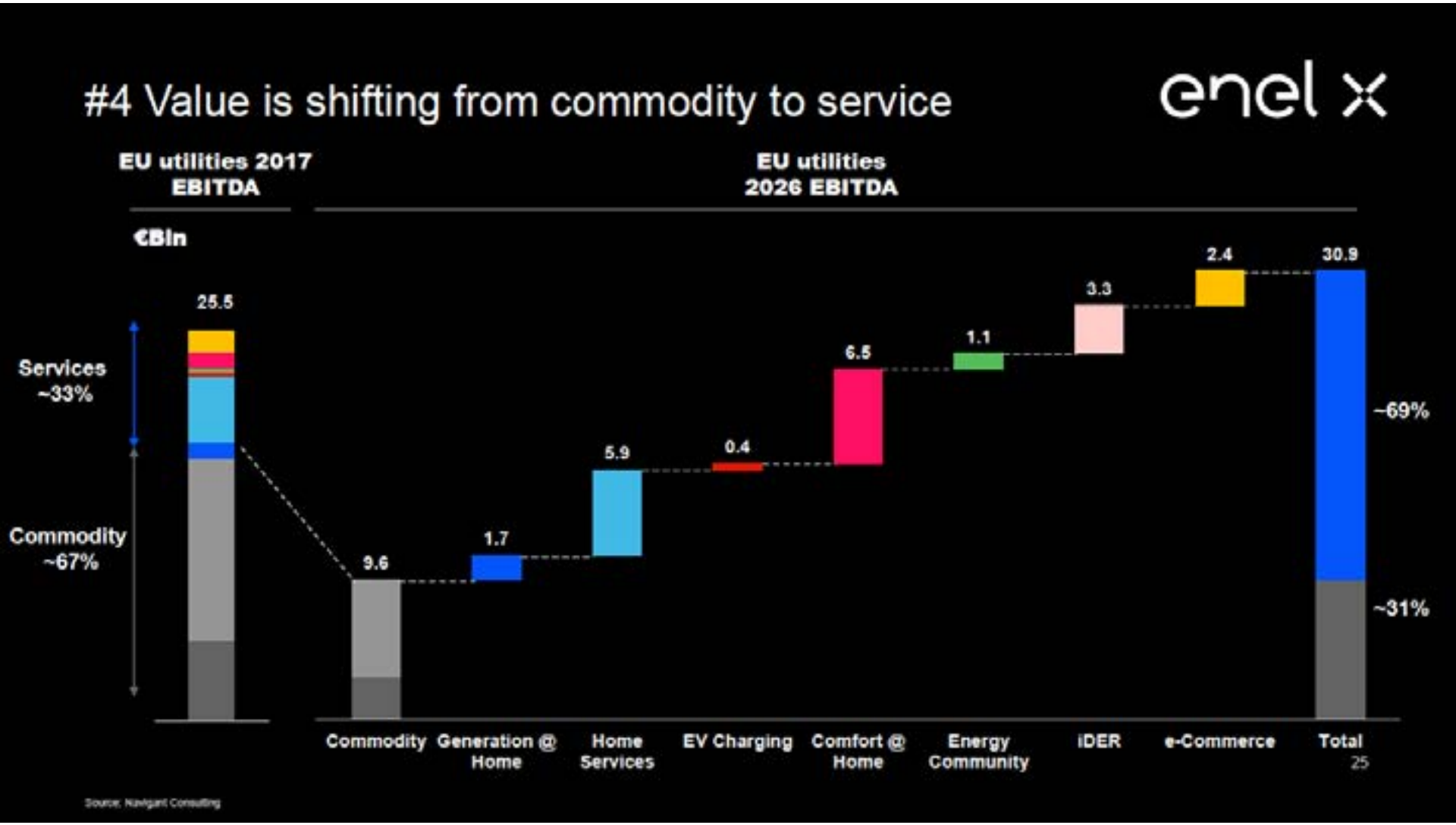
Case example: enel x



Case example: enel x



Case example: enel x



Case example: enel x

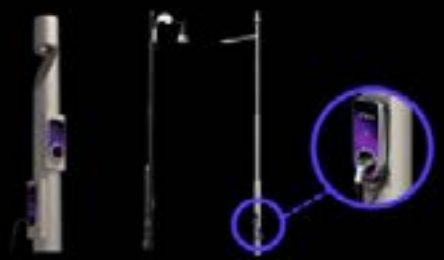
#1 Smart Lighting is evolving towards smart cities solutions

enel x

Smart Lighting Solutions

e-City counts **2.5 mn** of **lighting points worldwide**. In Italy about 1,700,000; in Chile 280,000; in Colombia 410,000 and in Spain 100,000.

Artistic lighting: portfolio of solutions targeting architectural "attractions" driving both artistic/decorative enhancement and energy savings



Smart City Solutions

e-City offers to governments, public administrations and municipal utilities a comprehensive portfolio of **energy related digital solutions**.

Energy efficiency, video surveillance, urban analytics, urban advertising, e-Bus services and other lighting related ancillary services.

UBB

e-City aims to become a **multi-regional wholesale fiber operator in LATAM**, leveraging synergies with Enel's power distribution network.

- ***Ultra Broadband connectivity (FTTx) for residential and enterprise;***
- ***4G network densification;***
- ***5G introduction;***
- ***IOT and smart city infrastructure.***

Case example: enel x

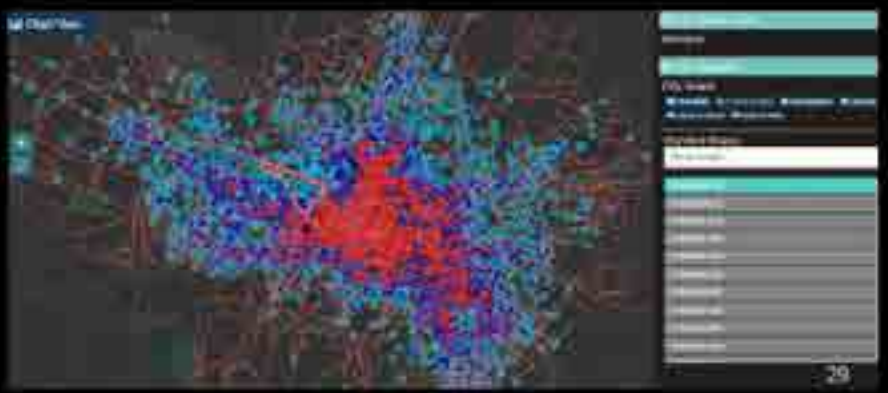
#1 From public lighting to city analytics

enel x

BIG DATA analysis on user presence to plan services, according to real demand

ANALYTICS on key city areas and points of interests, to analyse flow of people and traffic

PLANNING assets location through the evaluation of users habits (i.e. geo-behaviour)



4

"Allow DERs participate in wholesale markets"

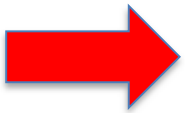
Wholesale market design should be improved to better **integrate** distributed resources, reward greater **flexibility**, and create a **level playing field** for all technologies

How to remove inefficient barriers?

- Wholesale markets should **enable transactions** to be made **closer to real time**

How to remove inefficient barriers?

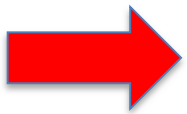
- Wholesale markets should **enable transactions** to be made **closer to real time**



Wholesale **market rules** *(such as bidding formats)* **should be updated** to reflect the operational constraints of new resources

How to remove inefficient barriers?

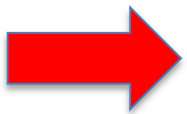
- Wholesale markets should **enable transactions** to be made **closer to real time**
- Wholesale **market rules** *(such as bidding formats)* **should be updated** to reflect the operational constraints of new resources



Aligning reserves & energy markets & establish the flexibility requirements for participation

How to remove inefficient barriers?

- Wholesale markets should **enable transactions** to be made **closer to real time**
- Wholesale **market rules** *(such as bidding formats)* **should be updated** to reflect the operational constraints of new resources
- **Aligning reserves & energy markets** & establish the flexibility requirements for participation



Minimize the interference of support mechanisms for clean technologies in electricity markets

entsoe

Electricity Balancing

The Electricity Balancing Guideline is about creating a market where countries can share the resources used by their transmission system operators to make generation equal demand always. It is also about allowing new players such as demand response and renewables to take part in this market. All in all, the Balancing Guideline should help increase security of supply, limit emissions and diminish costs to customers.

Current Status

✓ **Entered into force**

Read the guideline

COMMISSION REGULATION (EU) 2017/2195

of 23 November 2017

establishing a guideline on electricity balancing

(Text with EEA relevance)

THE EUROPEAN COMMISSION,

Having regard to the Treaty on the Functioning of the European Union,

Having regard to Regulation (EC) No 714/2009 of the European Parliament and of the Council of 13 July 2009 on conditions for access to the network for cross-border exchanges in electricity and repealing Regulation (EC) No 1228/2003 ([1]) and in particular Articles 18(3)(b), 18(3)(d) and 18(5) thereof,

Whereas:

(1) A fully functioning and interconnected internal energy market is crucial for maintaining security of energy supply, increasing competitiveness and ensuring that all consumers can purchase energy at affordable prices.

(2) A well-functioning internal market in electricity should provide producers with appropriate incentives for investing in new power generation, including in electricity from renewable energy sources, paying special attention to the most isolated Member States and regions in the Union's energy market. A well-functioning market should also provide consumers with adequate measures to promote more efficient use of energy, which presupposes a secure supply of energy.

CNMC
COMISIÓN NACIONAL DE LOS MERCADOS Y LA COMPETENCIA

Propuesta trámite audiencia

PROPUESTA DE CIRCULAR X/2019, DE XXX DE XXX, DE LA COMISIÓN NACIONAL DE LOS MERCADOS Y LA COMPETENCIA, POR LA QUE SE ESTABLECEN LAS METODOLOGÍAS QUE REGULAN EL FUNCIONAMIENTO DEL MERCADO DE PRODUCCIÓN DE ELECTRICIDAD Y LA GESTIÓN DE LA OPERACIÓN DEL SISTEMA

Desde el año 1999 se ha ido implantando gradualmente en toda la Unión Europea el mercado interior de la electricidad. Dicho mercado interior tiene como finalidad dar una posibilidad real de elección a todos los consumidores de la Unión Europea, sean ciudadanos o empresas, de crear nuevas oportunidades comerciales y de fomentar el comercio transfronterizo, a fin de conseguir mejoras de la eficiencia, un aumento de la calidad del servicio y una mayor competitividad, y de contribuir a la seguridad del suministro y a la sostenibilidad.

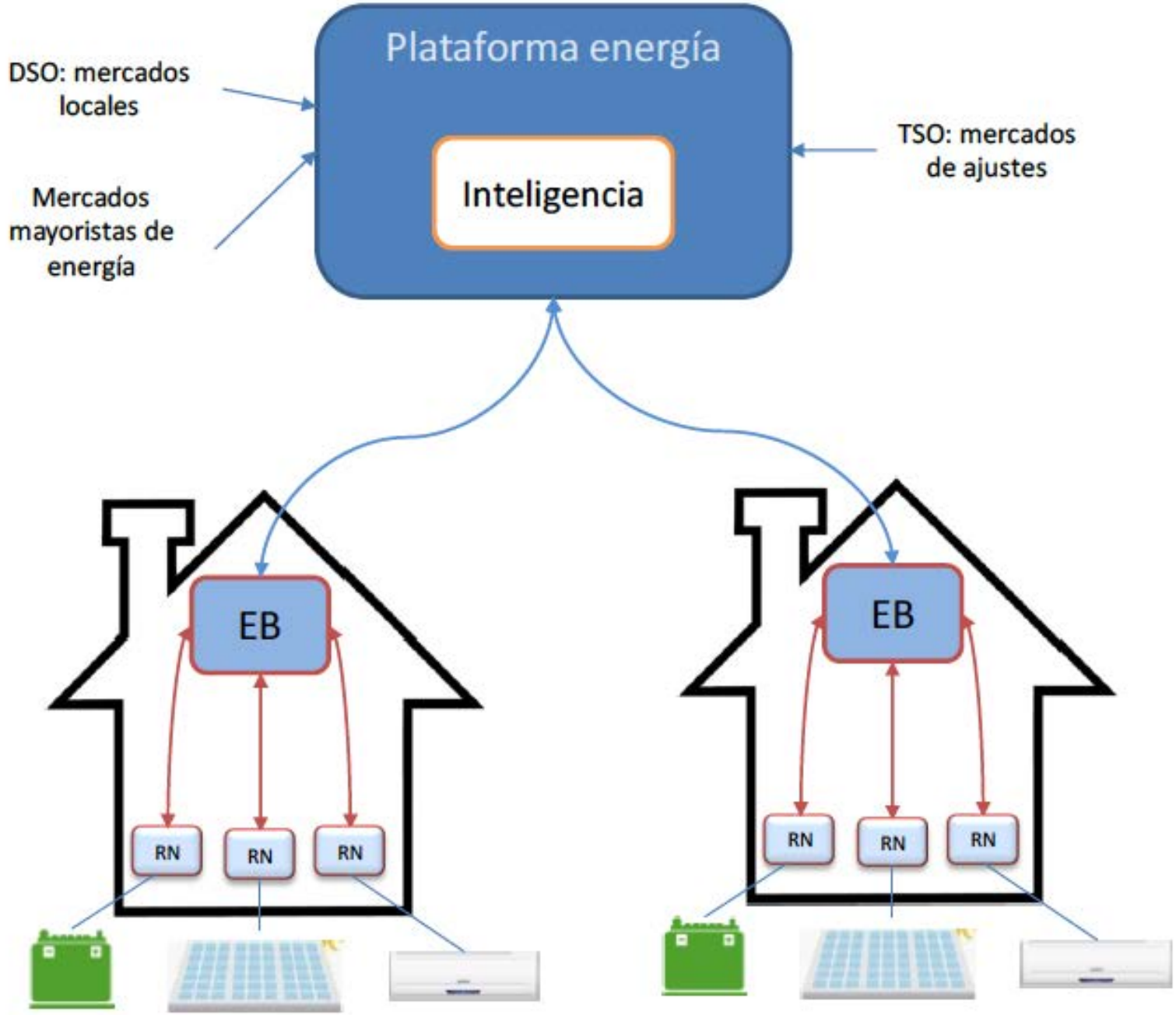
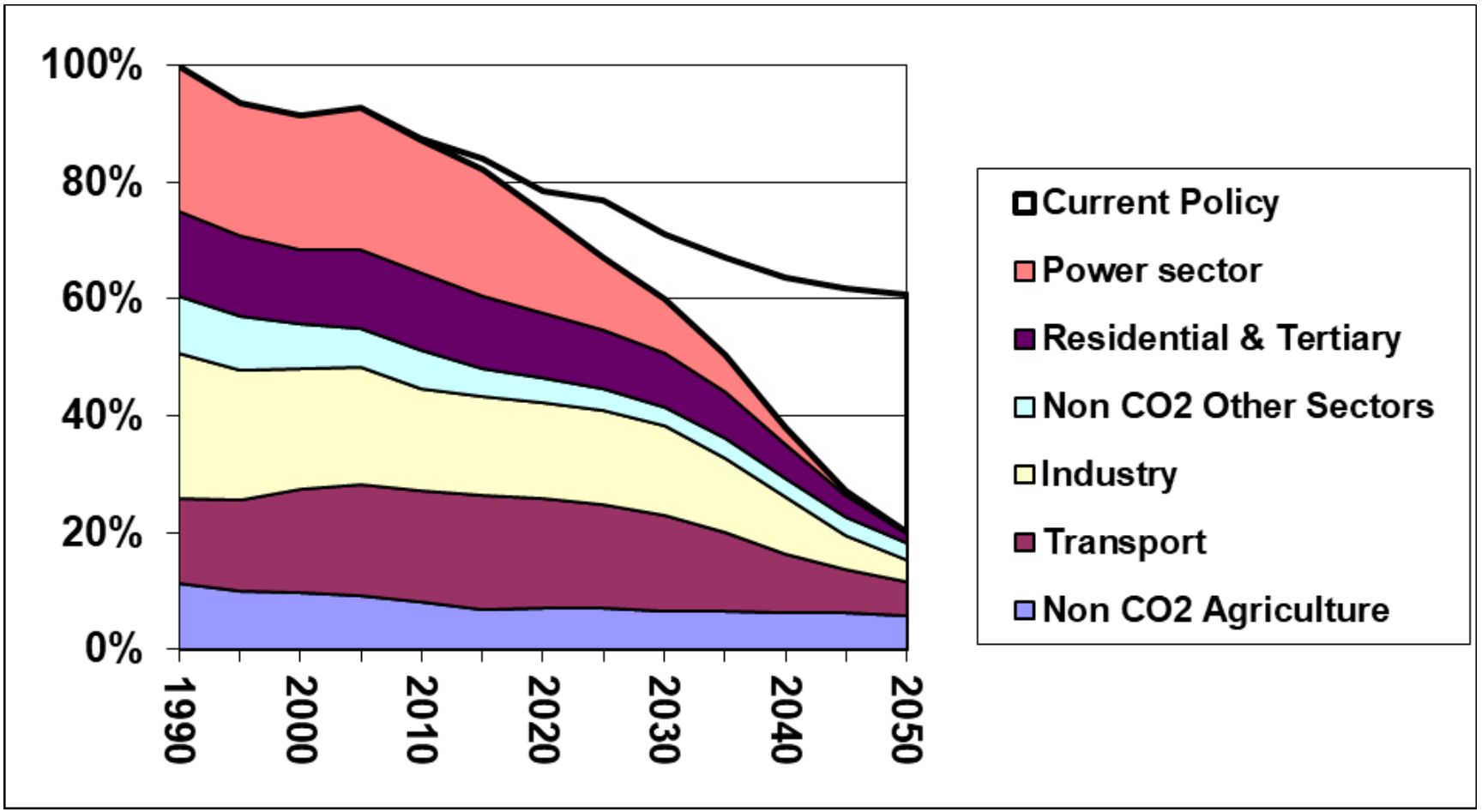


Figura 3-5 Modelos de negocio basados en la explotación colectiva de varios edificios.

Sectoral GHG 1990-2050



Concerns about a massive penetration of “variable” renewables of almost zero variable cost

- Wholesale electricity prices will collapse & no new investment will take place
- The need for firm generation capacity for times of low renewable output
- The need for flexibility to cope with renewables “variability”
- Operational security concerns
  - Frequency control
  - Voltage control & short circuit protection with strong presence of DERs
  - Short circuit protection

ELECTRICITY MARKET DESIGN
Energy, Reserves, Capacity, Transmission, Pricing And the Green Agenda

William W. Hogan

Mossavar-Rahmani Center for Business and Government
John F. Kennedy School of Government
Harvard University
Cambridge, Massachusetts 02138

HEEP ENEL Foundation Workshop

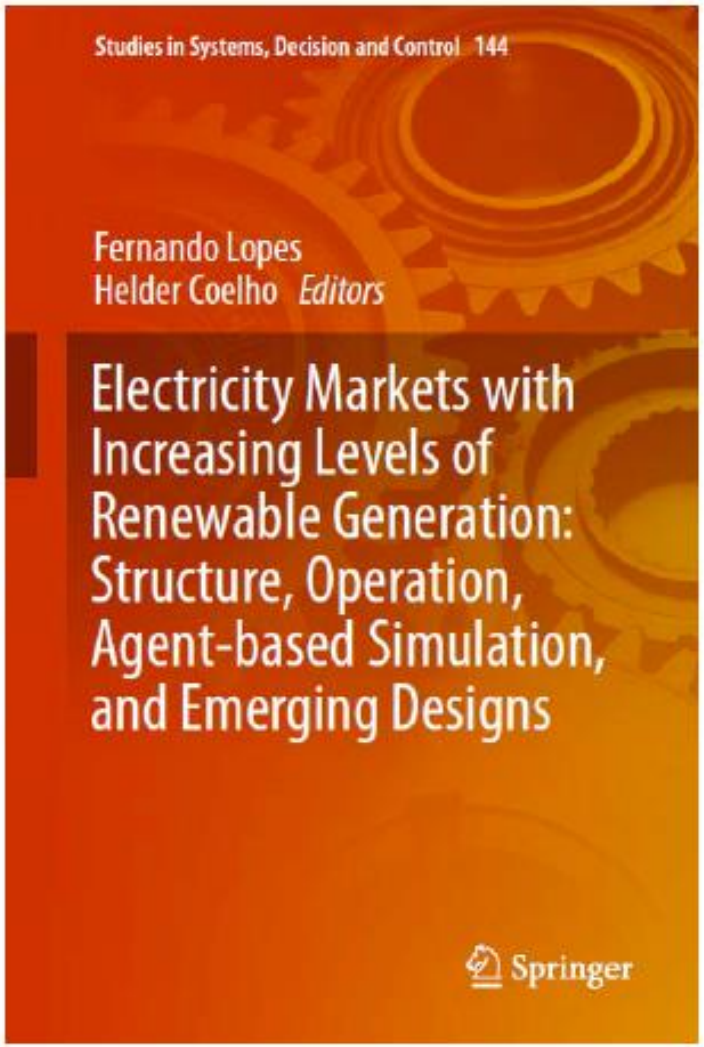
Analysis and Management of

Energy and Environmental Policy

May 9, 2019

A major challenge is the integration of increasing levels of renewables. There is a large and growing literature on the subject. (Lopes & Coelho, 2018) (Hogan & Pope, 2017)

- **Are renewables fundamentally different?**
  - Zero marginal cost, which affects the system economics.
  - Intermittency of supply, which affects system operations.
- **Will increasing levels of renewables require a fundamentally new approach to electricity market design?**
  - Clean Power Plan mandates with effects both on investment and operations.
  - Expanded state subsidies (NY, IL), inconsistent carbon markets (CA and EIM), net energy metering (Belmont, MA), and ever present rent seeking.
- **What is wrong with the existing market design fundamentals?**



December 18, 2018

Challenges for wholesale electricity markets with intermittent renewable generation at scale: The U.S. Experience

Paul L. Joskow[1]

Abstract: The supply of intermittent wind and solar generation with zero marginal operating cost is increasingly rapidly in the U.S. These changes are creating challenges for wholesale markets in two dimensions. Short term energy and ancillary services markets, built upon mid-20th century models of optimal pricing and investment, which now work reasonably well, must accommodate the supply variability and energy market price impacts associated with intermittent generation at scale. These developments raise more profound questions about whether the current market designs can be adapted to provide good long-term price signals to support investment in an efficient portfolio of generating capacity and storage consistent with public policy goals. The recent experience of the California ISO (CAISO) is used to illustrate the impact of intermittent generation on supply patterns, supply variability, and market-based energy prices. Reforms in capacity markets and scarcity pricing mechanisms are needed if policymakers seek to adapt the traditional wholesale market designs to accommodate intermittent generation at scale. However, if the rapid growth of integrated resource planning, subsidies for some technologies but not others, mandated long term contracts, and other expansions of state regulation continues, more fundamental changes are likely to be required in the institutions that determine generator and storage entry and exit decisions.

Key Words: electricity, renewable energy, intermittency, wholesale electricity markets

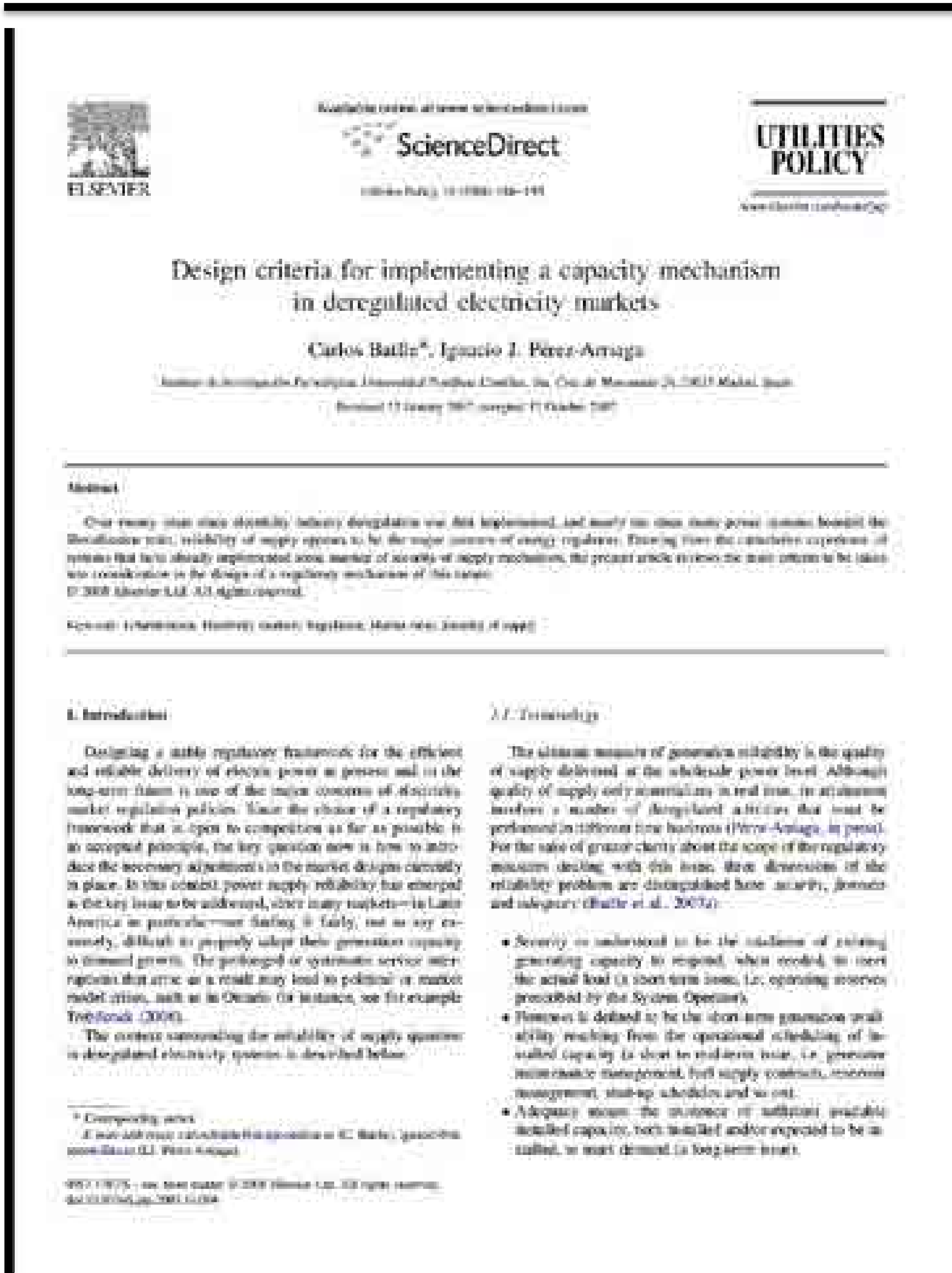
JEL classification: L51, L94, L98, Q41, Q48, Q55

I. Introduction

This paper examines the current and likely future effects on wholesale electricity markets and the challenges these markets face due to the rapid expansion of intermittent (or variable) renewable energy,

[1] Elizabeth and James Killian Professor of Economics, MIT and Research Associate, National Bureau of Economic Research. The views expressed here are my own and do not reflect the views of MIT, the National Bureau of Economic Research or any other entities with which I an affiliated. I am grateful to Richard Schmalensee for extensive discussions of many of the issues discussed in this paper and to Patrick Brown for providing assistance in organizing and displaying the CAISO data. The CAISO data displayed in the figures come from the CAISO web site and are all publicly available. http://oasis.caiso.com/mrioasis/logon.do . The daily generation data were collected from the CAISO web site and organized in the Platts Megawatt Daily Fundamental Data to which I subscribe. MIT provided support for my research. A list of my affiliations can be found at http://economics.mit.edu/files/15081. I note in particular that I am on the board of directors of Exelon Corporation which has an interest in the issues discussed here, though I have not discussed with Exelon the content of this paper. Finally, Deiter Helm and two and two anonymous referees have provided very helpful comments on an earlier version of this paper.

Capacity mechanisms


ScienceDirect

UTILITIES POLICY

ELSEVIER

Design criteria for implementing a capacity mechanism in deregulated electricity markets

Carlos Batlle*, Ignacio J. Pérez-Arriaga

Abstract

1. Introduction

1.1. Terminology


Energy Policy

ELSEVIER

Security of electricity supply at the generation level: Problem analysis

P. Rodilla*, C. Batlle

ARTICLE INFO

ABSTRACT

1. Introduction

2. Is the market capable of ensuring a reliable supply?

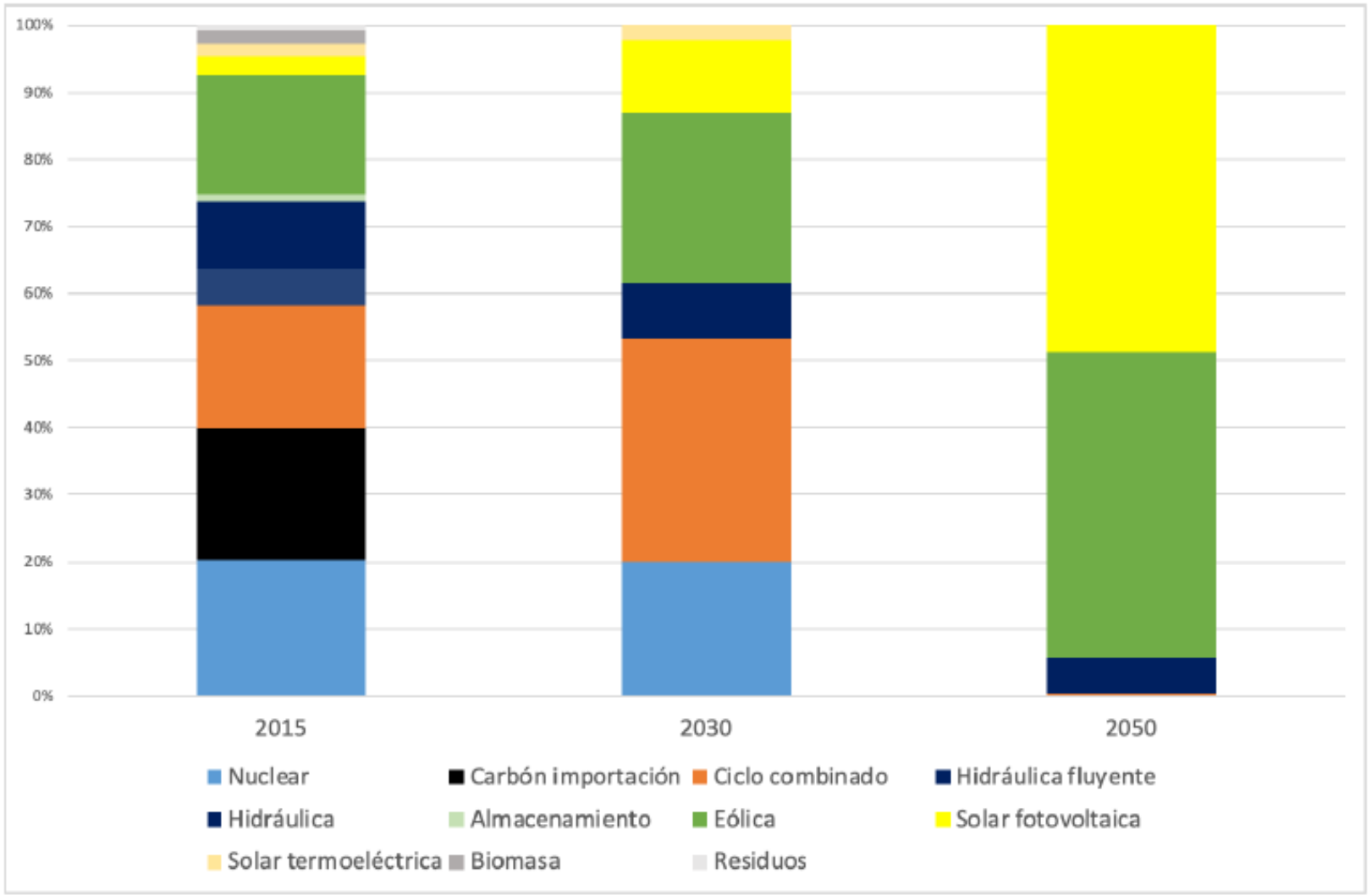


Figura 1-3 Evolución del mix eléctrico español según el estudio (Economics for Energy, 2018)

La cuota de electrificación podría alcanzar el 80% del transporte, el 75% del sector residencial y el 100% del sector terciario, siendo en el sector industrial donde se plantean las mayores incertidumbres. La demanda eléctrica debería crecer, en este escenario de descarbonización, un 90% con respecto a la de 2015.

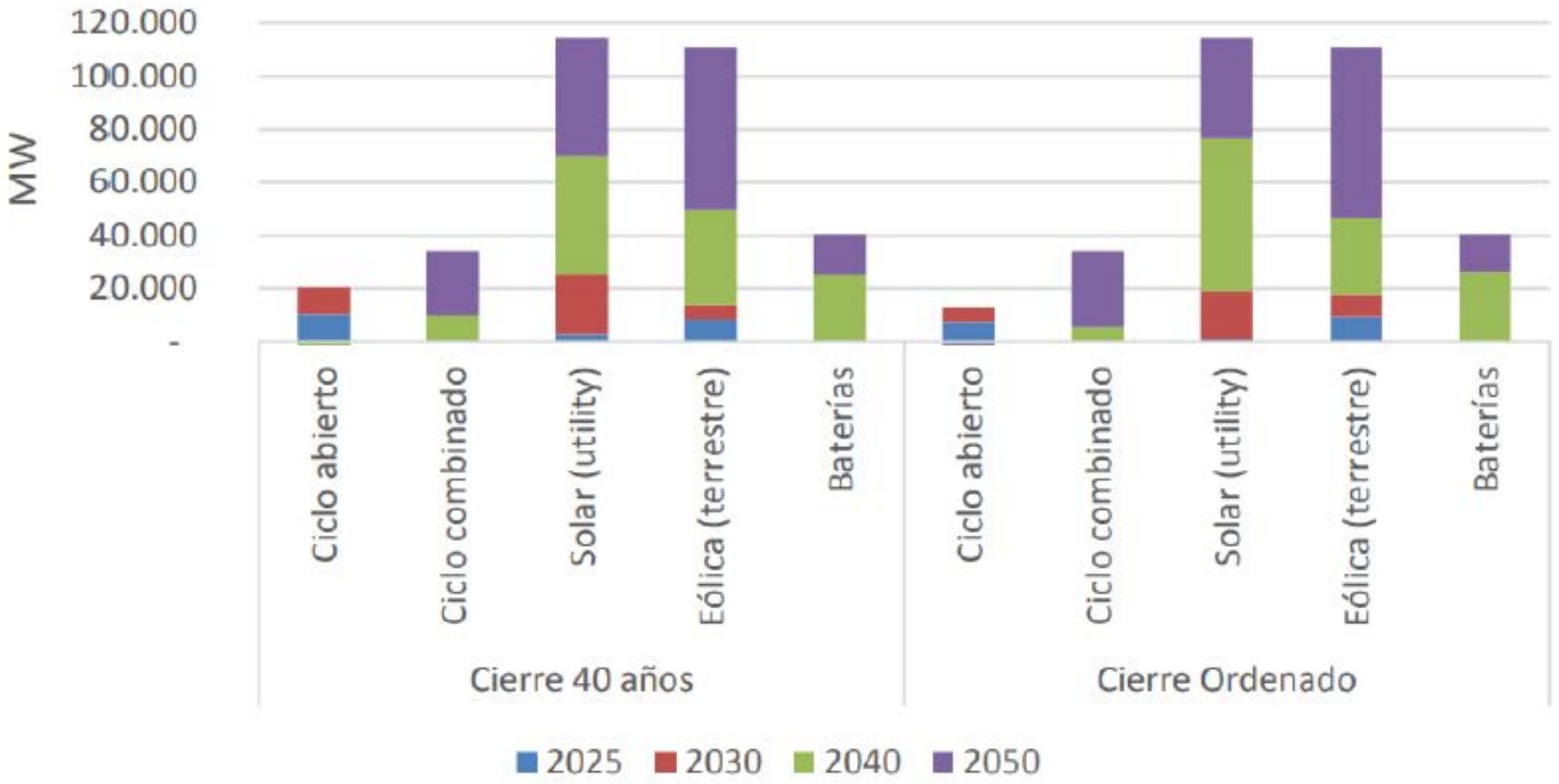
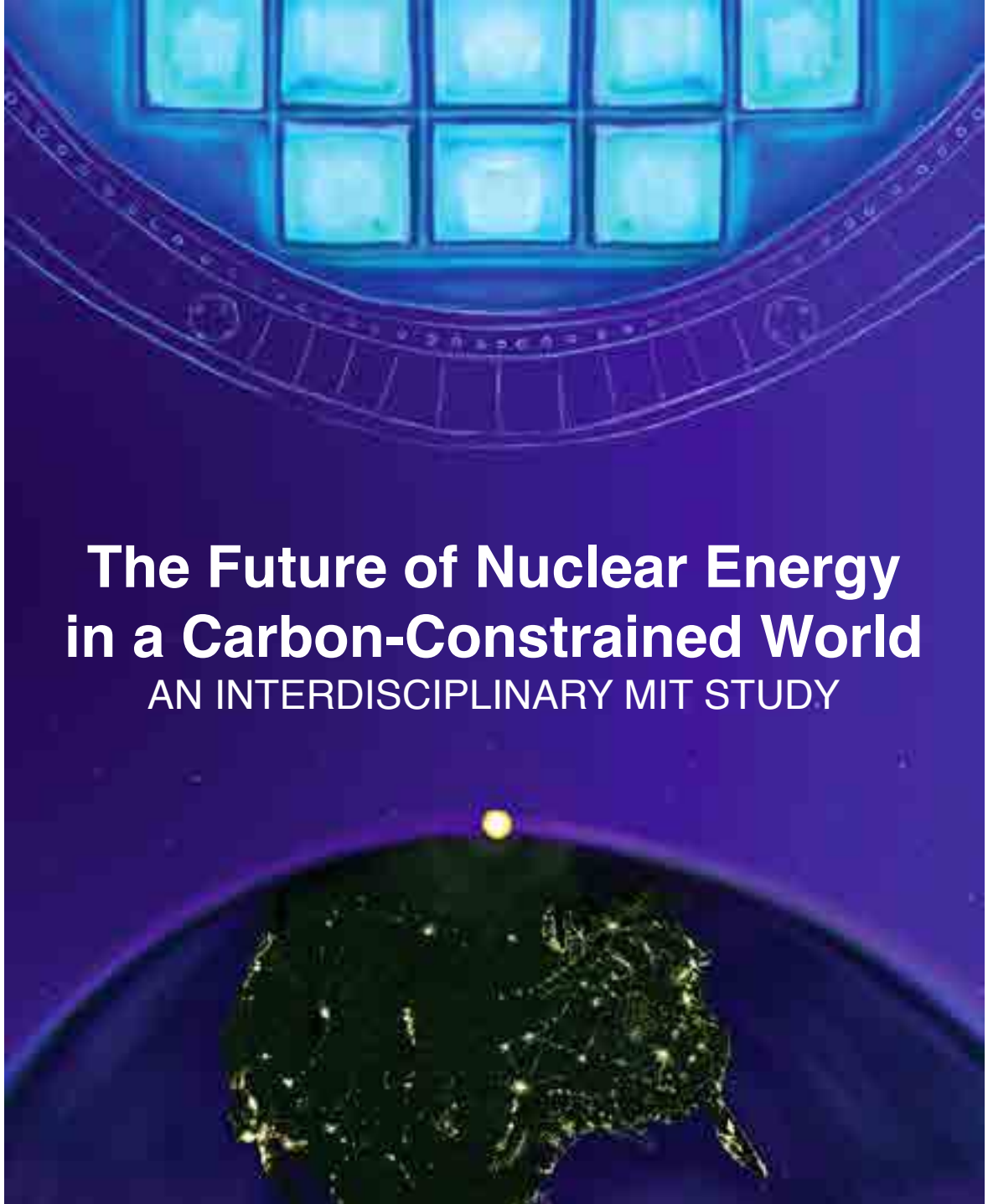


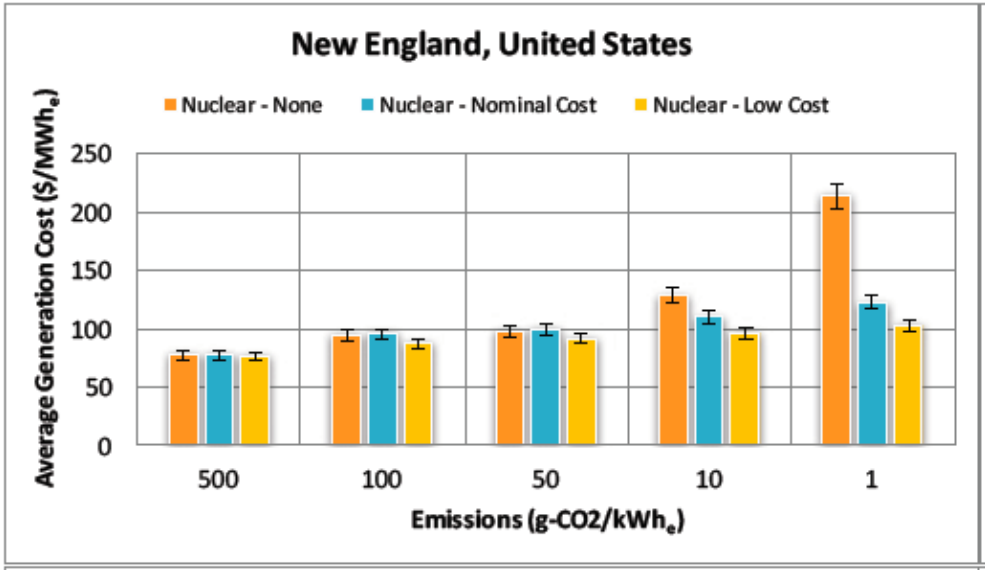
Figura 5-4.- Inversiones en MW por tecnología para un 2% de crecimiento de demanda. Comparativa de dos escenarios relativos a la evolución del cierre de las centrales nucleares (40 años y cierre ordenado). Fuente (Rivier et al, 2017)

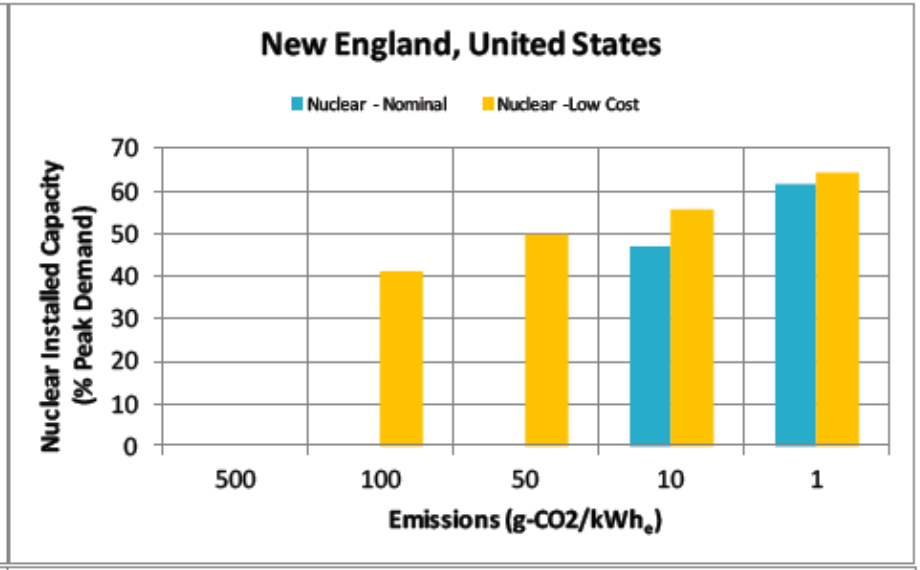


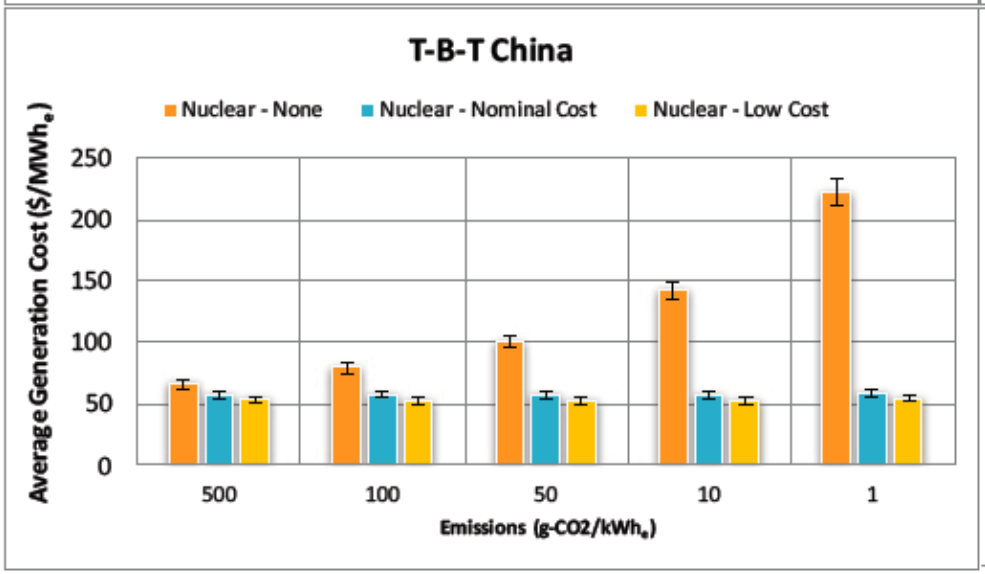
The Future of Nuclear Energy in a Carbon-Constrained World

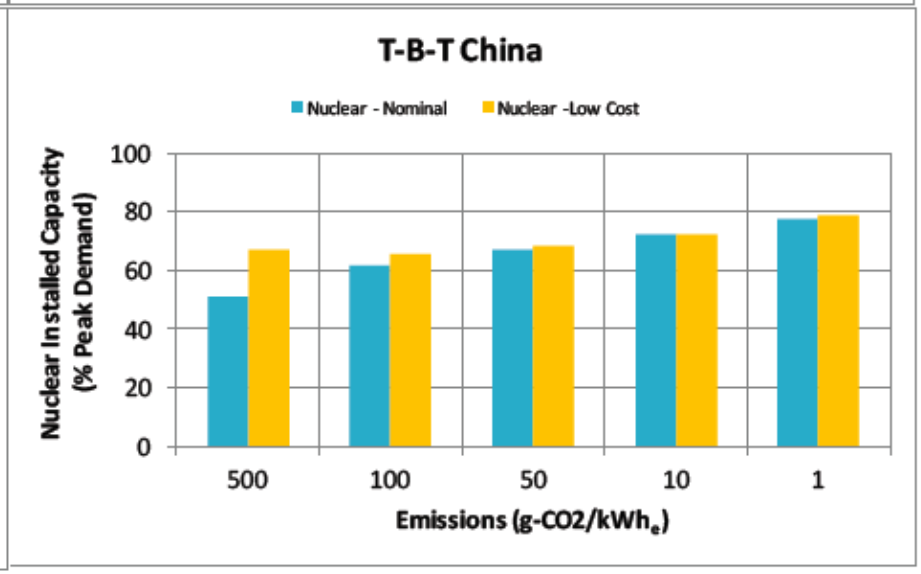
AN INTERDISCIPLINARY MIT STUDY

Figure E.1: (left) Average system cost of electricity (in $/MWh$_e$) and (right) nuclear installed capacity (% of peak demand) in the New England region of the United States and the Tianjin-Beijing-Tangshan (T-B-T) region of China for different carbon constraints (gCO_2/kWh$_e$) and three scenarios of various available technologies in 2050: (a) no nuclear allowed, (b) nuclear is allowed at nominal overnight capital cost ($5,500 per kW$_e$ for New England and $2,800 per kW$_e$ for T-B-T), and (c) nuclear is allowed with improved overnight capital cost ($4,100 per kW$_e$ for New England and $2,100 per kW$_e$ for T-B-T)

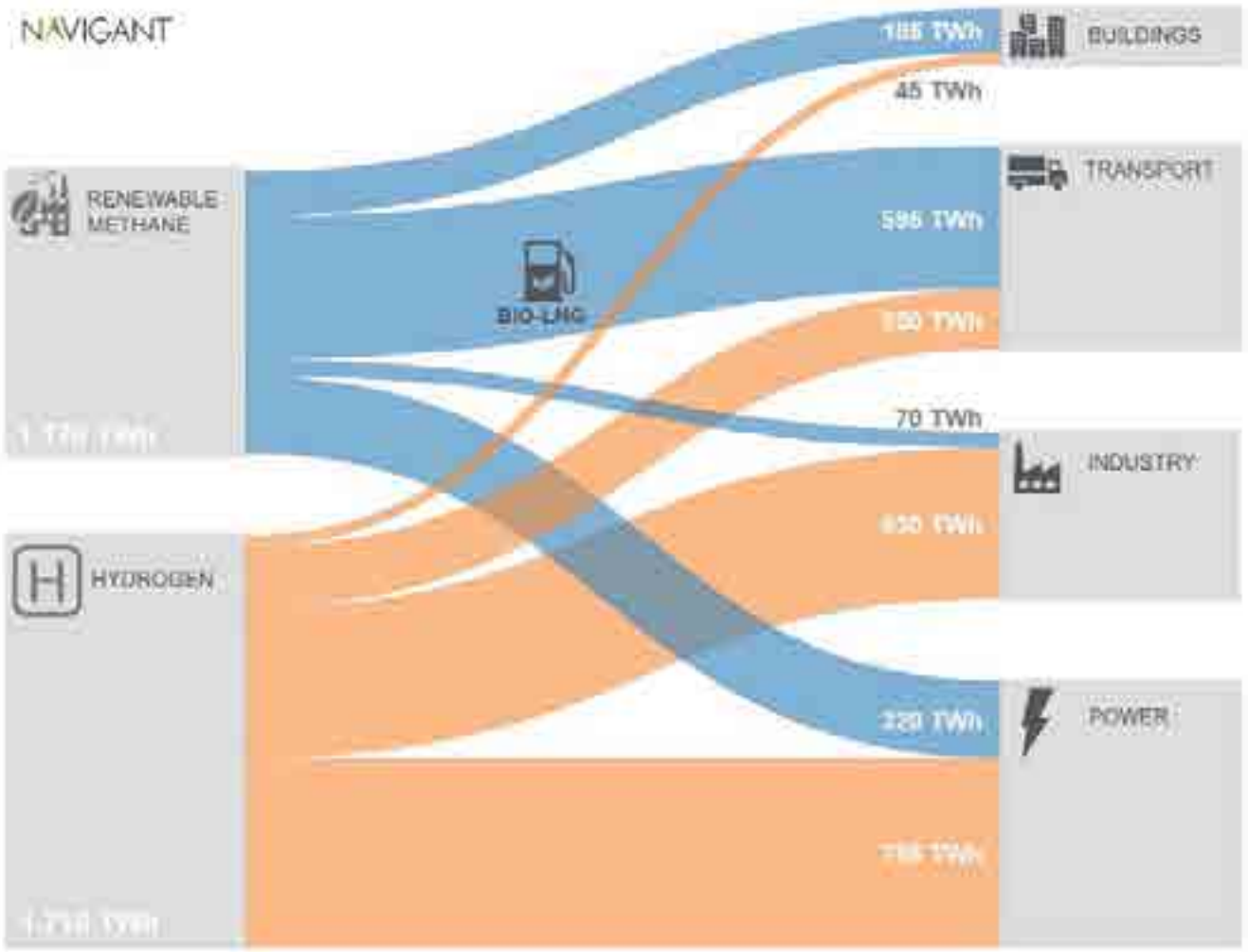








Renewable and low-carbon gas supply and demand



Renewable and low-carbon gas supply and demand in the "optimised gas" scenario (Source: Navigant, 2019)

5

"Carefully evaluate the economic opportunities and costs of DERs"

Better utilization of **existing assets** and smarter energy consumption hold great potential for cost savings.

Economies of scale still matter, and the distributed deployment of **solar PV** or energy **storage** is not cost-effective in all contexts and locations

Some DERs can only be deployed at a specific scale level…

… while others can be deployed at different scales

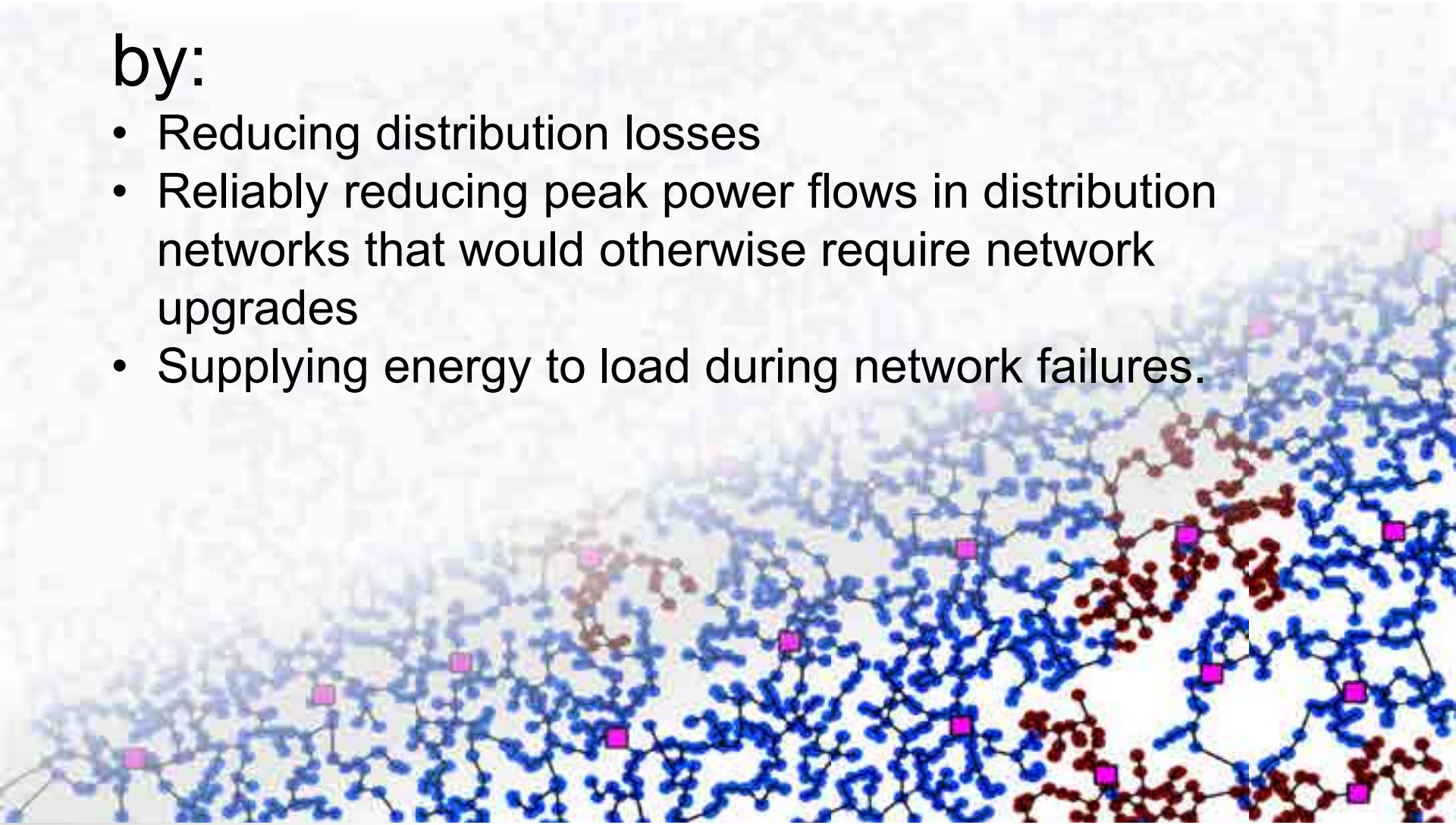
Utility Scale

C&I Scale

Residential Scale

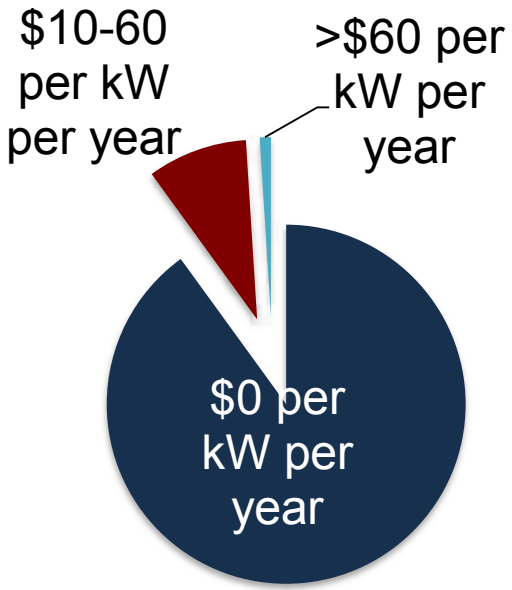
DERs can create locational value by:

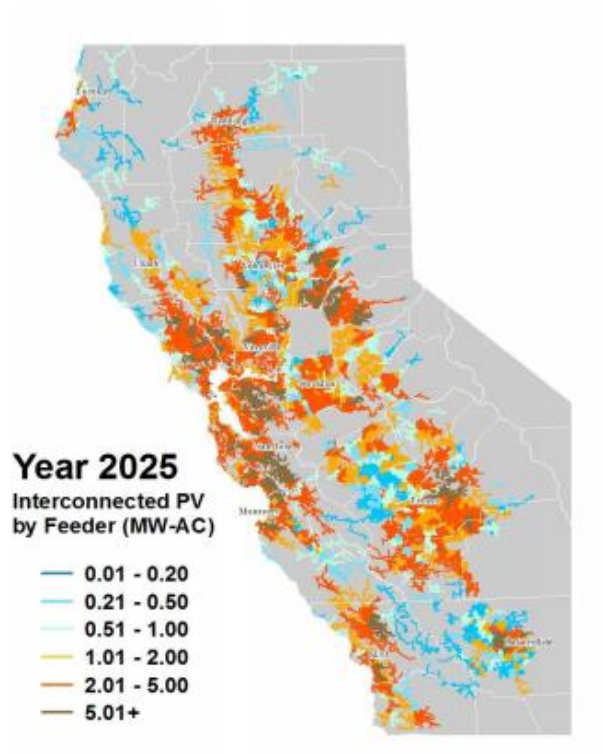
- Reducing distribution losses
- Reliably reducing peak power flows in distribution networks that would otherwise require network upgrades
- Supplying energy to load during network failures.



When installed in the right locations and operated intelligently, DERs can bring significant benefits to the power sector

Capacity benefit of distributed solar PV in PG&E's network





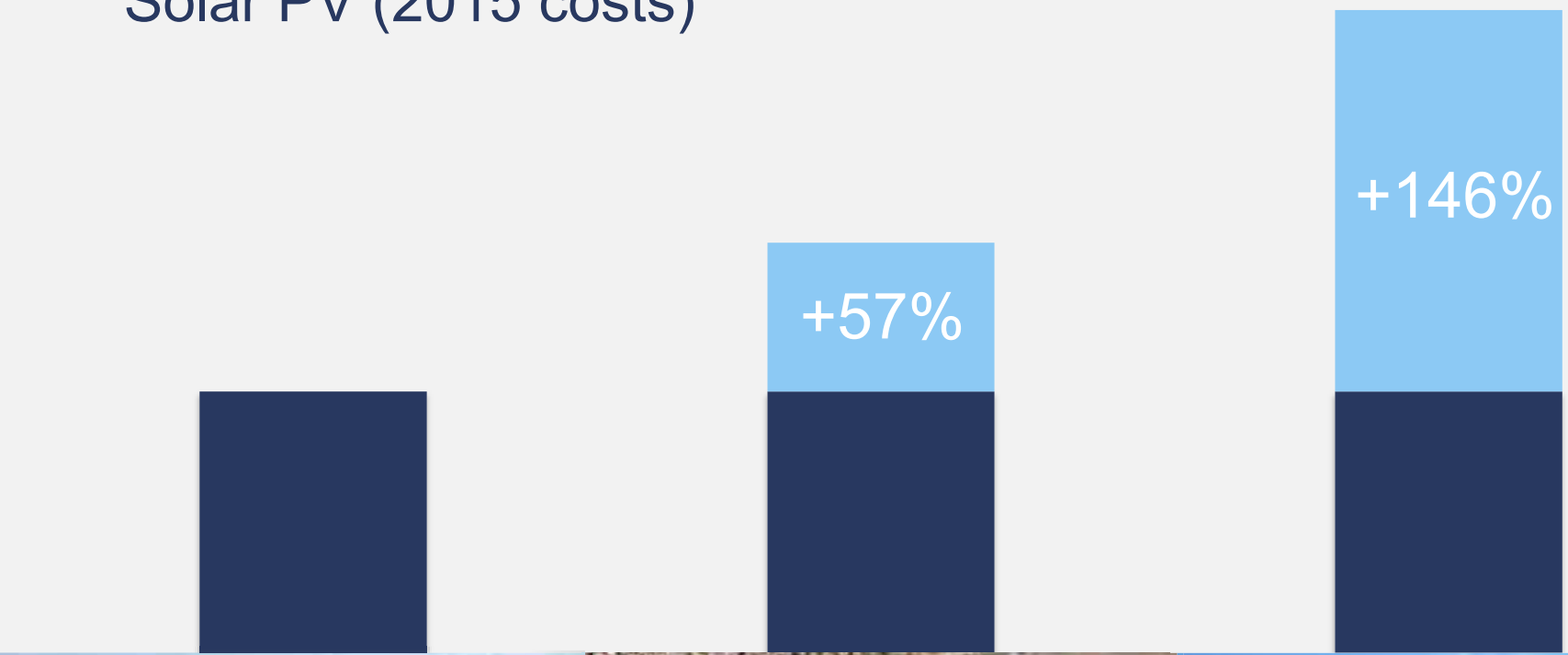
Source: M.A. Cohen, P.A. Kauzmann, D.S. Callaway, Effects of distributed PV generation on California's distribution system, part 2: Economic analysis, Solar Energy, Volume 128, 2016, 139–152

For DERs that can be deployed at different scales (e.g. solar PV, storage)…

Locational value competes with economies of scale

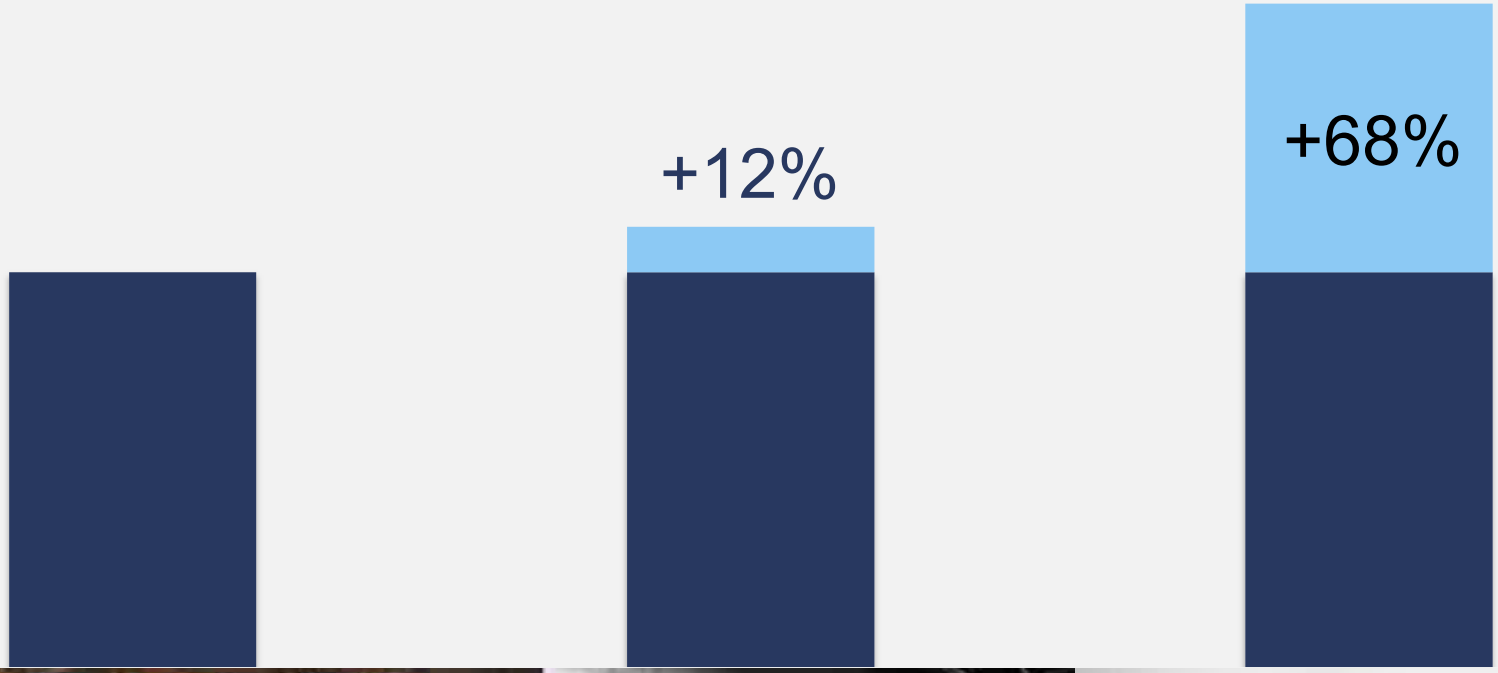
Economies of Unit Scale Still Matter

Solar PV (2015 costs)



Economies of Unit Scale Still Matter

Lithium-ion Energy Storage (2015 costs)

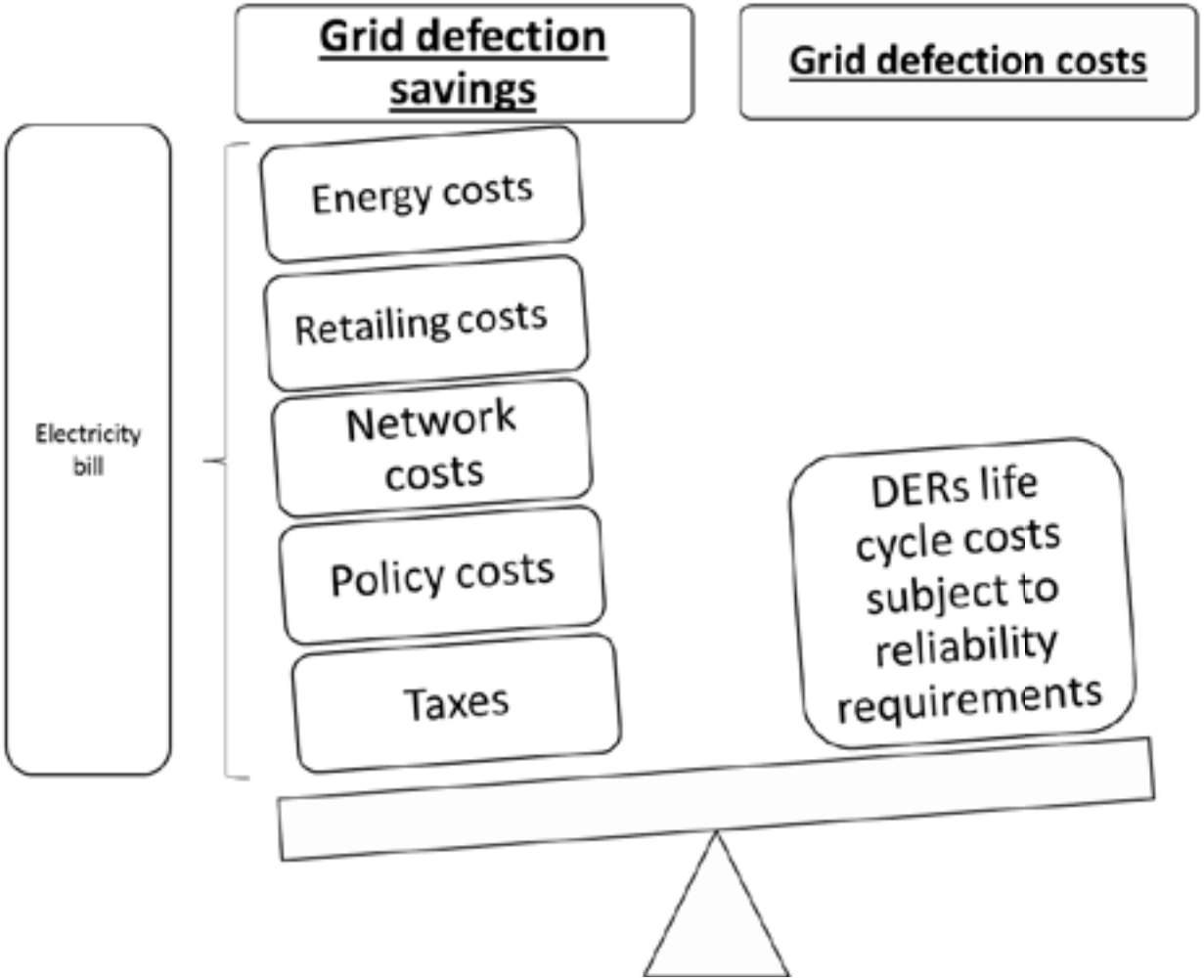


Distributed or centralized?

- From a **societal viewpoint**, the locational value *versus* the incremental cost due to loss of economies of scale determines the best option
- From the **customer viewpoint**, *the locational value enhances the economic viability of the distributed resource*, which will be a factor among others to make a decision

Will the future of the electric power be distributed?

Promoting grid defection for the wrong reasons should be avoided



IEEE PES ISGT NA 2019

Panel Session

Wednesday (2/20)

Grid Connected Buildings as a Transactive Hub

Session Chair: F. Rahimi, *OATI*

Panelists:

R. Ambrosio (*Utopus Insights*)

M. Knight (*Burns & McDonnell*)

G. Gray (*EPRI*)

T. Barham (*PECI*)

2019 ISGT North America

SMARTGRID PES IEEE

How buildings can play a central role as transactive hubs

Mark Knight

BURNS McDONNELL

CREATE AMAZING.

IEEE PES Power & Energy Society

IEEE

Using Transactive Energy / Markets to Integrate DER

Dr. Gerald R. Gray
Senior Program Manager
Electric Power Research Institute

IEEE PES Power & Energy Society

IEEE

Grid Evolution Motivation/Themes

Motivation

- Technology is advancing rapidly
- Evolving capabilities bring:
  - New opportunities
  - New concerns / challenges
  - Structural change
- Modular and scalable technologies enable:
  - Disaggregation of system physics
  - Hyper-local optimization
  - A new set of cascading concerns
- Distribution models diversifying
- Interoperability more critical than ever
- Interoperability more challenging than ever

Framework 4.0 Themes (Draft)

- Structural changes are occurring in the grid
- System complexity is increasing
  - Interoperability is a critical element of modern grid function
- No single architecture is correct
  - Common trends
  - Unique conditions
- Grid architectures affect:
  - Operations
  - Economics
  - Cybersecurity
- As actors take on new roles within the system and new economic forces emerge, interoperability gains new dimensions
  - Testing & Certification

What is Transactive Energy?

- "techniques for managing the generation, consumption or flow of electric power within an electric power system through the use of economic or market based constructs while considering grid reliability constraints."
- "a system of economic and control mechanisms that allows the dynamic balance of supply and demand across the entire electrical infrastructure using value as a key operational parameter"
- "a model in which generation, storage, and loads enabled by intelligent communications capabilities create the ability for customers and utilities to buy and sell between themselves based on mutual economic benefits"

Will the future of the electric power be distributed?

The future will be integrated


?
How to design the energy company of the future here?

Muchas gracias