IRENA
International Renewable Energy Agency

Electrificación inteligente del uso final de la energía

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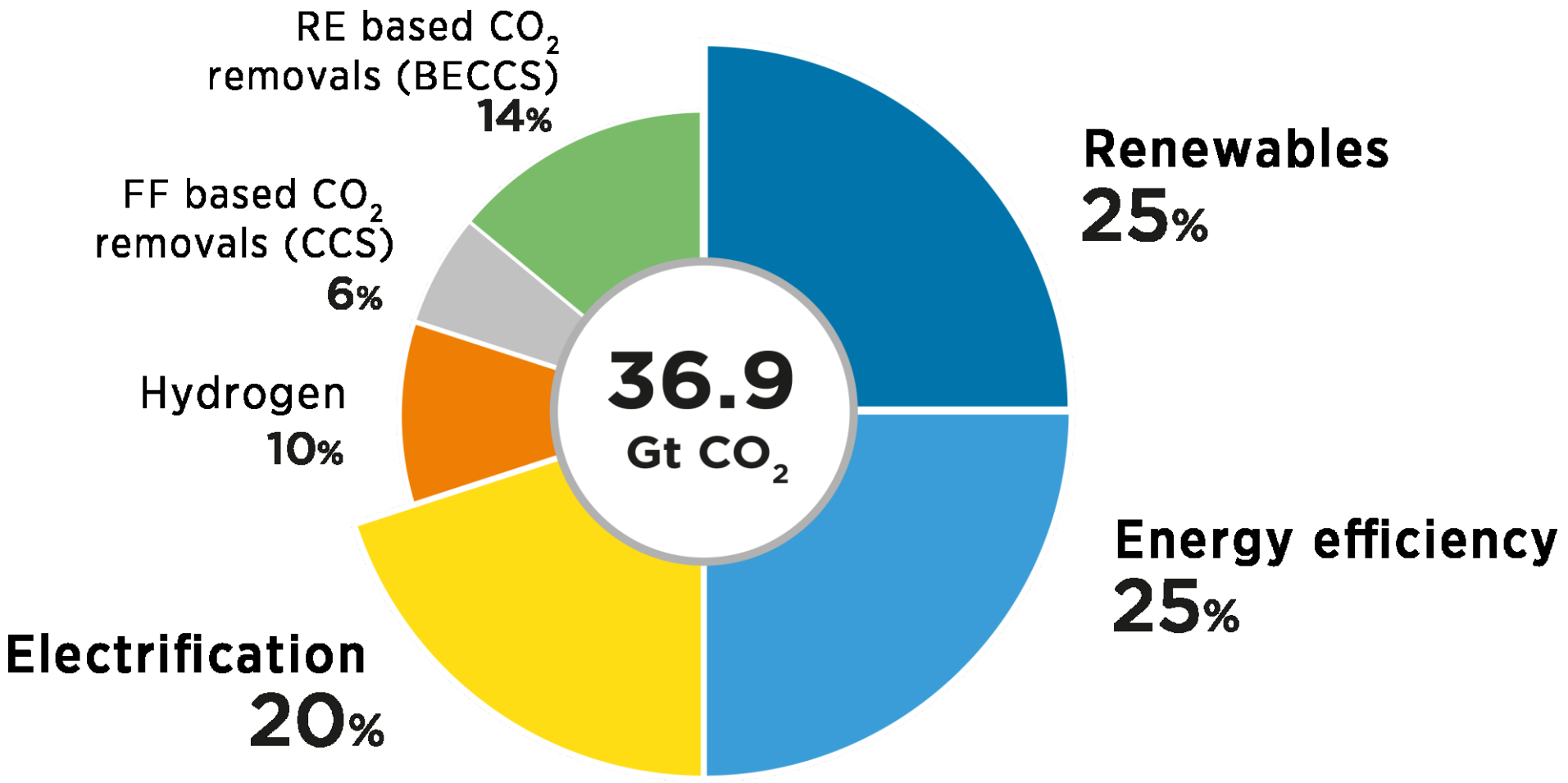
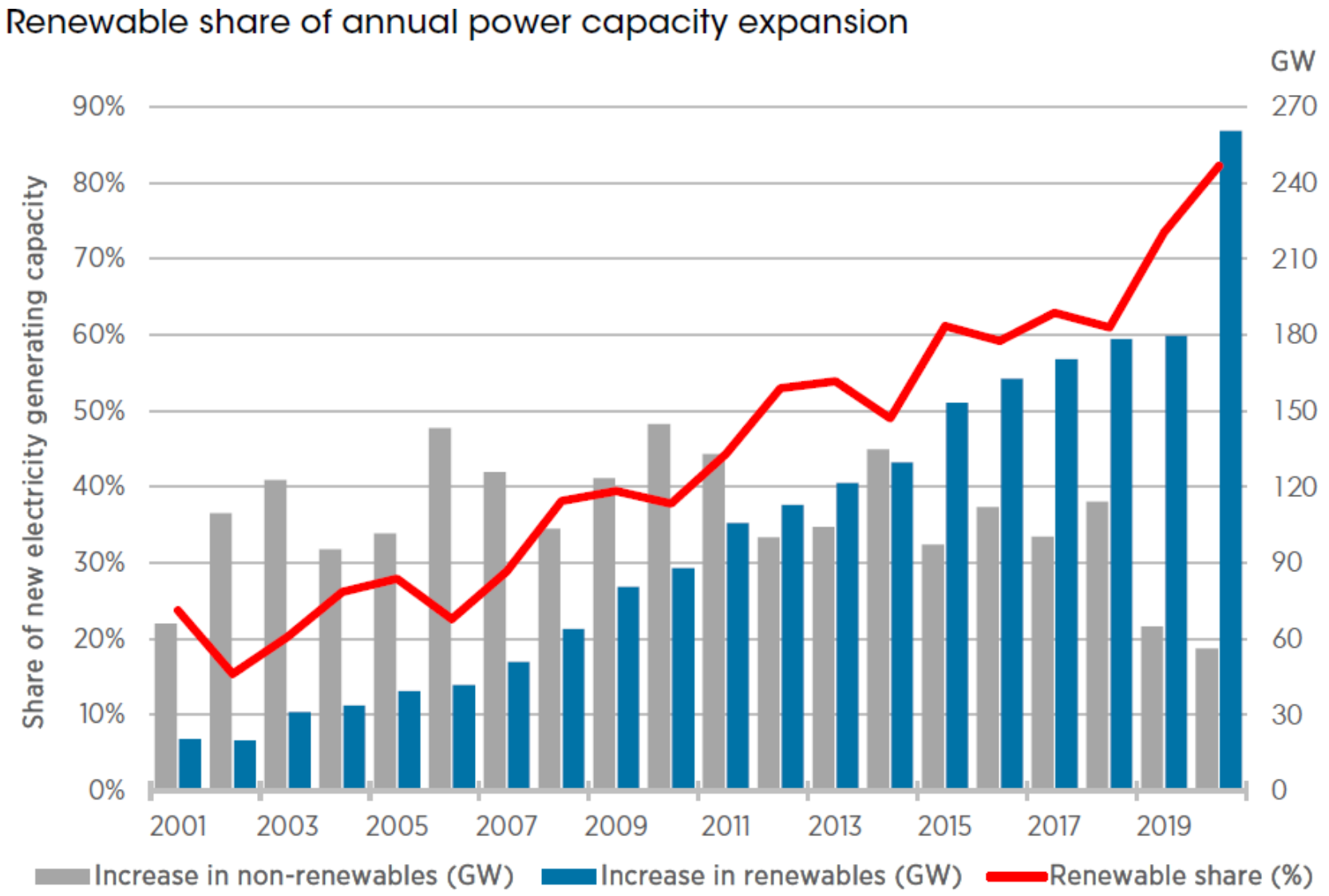
International Renewable Energy Agency - IRENA

Tercer Foro XM
8 julio2021

Seis componentes de la transición energética



2020 ² un año magnifico para las renovables a pesar de la pandemia



Fuente: IRENA (2020), Renewable capacity

2 799 GW

Global renewable generation capacity at the end of 2020

10.3%

Growth in renewable capacity during 2020

261 GW

Net increase in global renewable generation capacity in 2020

64%

Share of new renewable capacity installed in Asia in 2020

91%

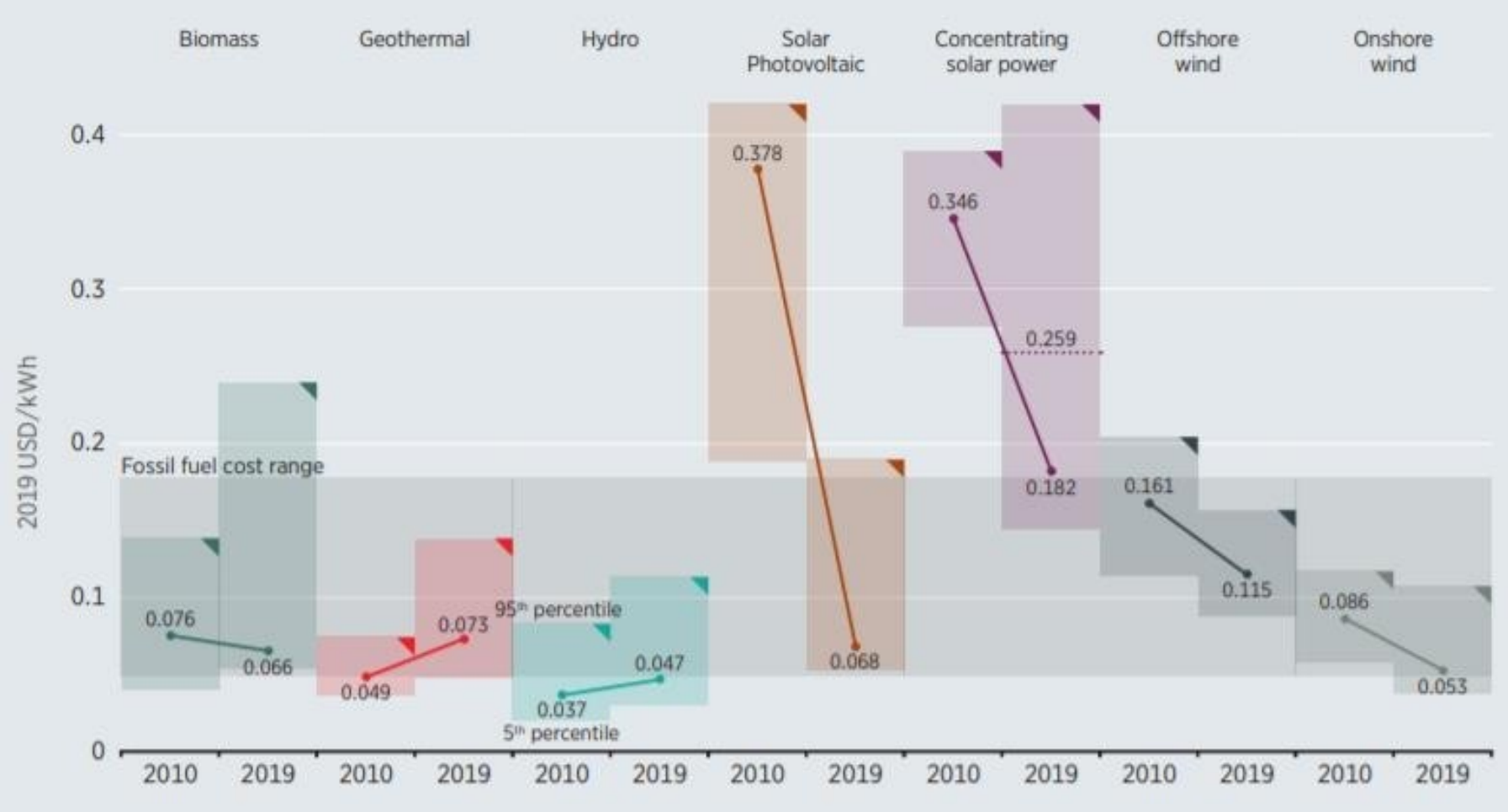
Wind and solar share of new capacity in 2020

82%

Share of renewables in net capacity expansion in 2020

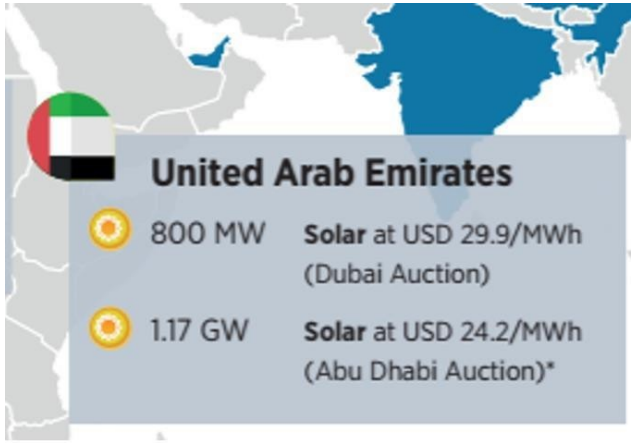
Energías renovables competitivas en el sector eléctrico

Costo Nivelado de la Electricidad



Fuente: IRENA (2020) Renewable Power Generation Costs in 2019

Subastas recientes



Hace una semana en Portugal
1.31 c USD/kWh

Rápida reducción de costos [2] *FV: 80% en los últimos 6 años*

Experiencia Europea durante la Pandemia

European electricity sector indicators for the period 01 Jan 2020 to 31 Dec 2020

Indicator	Value	Relative change against last year (2019)
Total generation (TWh)	2,935	- 4.4%
Average share of RE power generation	**40%**	+ 4.9%
RE generation (TWh)	1,162 Solar 160 (est) Wind 470 (est) Hydro 360 (est) Biomass 200 (est)	**+ 8.3%**
Other sources generation (TWh)	1,773	- **18% Coal** - 11% Nuclear - 7% Gas
Top 3 days with highest share of RE generation	5 Jul: **55%** 6 Jun: 53% 24 May: 53%	

Source: https://www.wartsila.com/energy/transition-lab; EMBER/Agora

EU-27, UK, NO, SW

Energías renovables variables en sistema eléctrico colombiano

Figure 2: Expected evolution of Colombia's generation capacity mix, 2017-2030

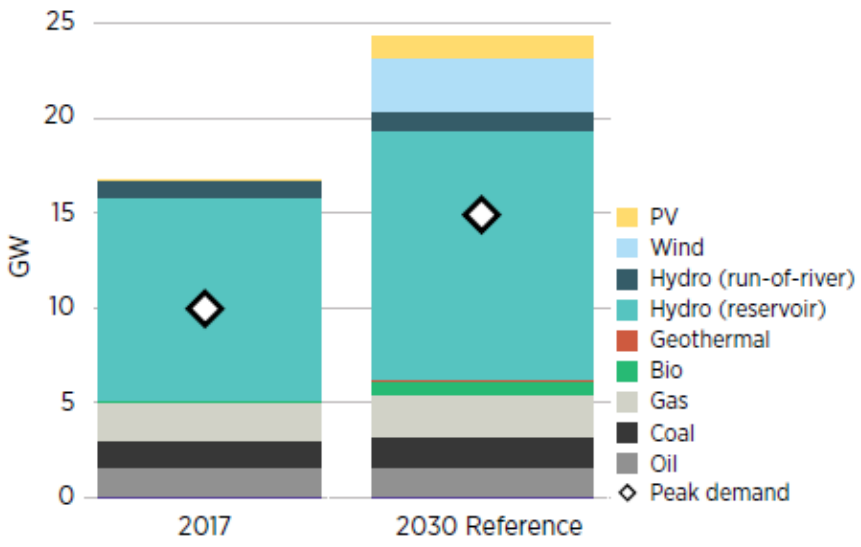


Table 1: Flexibility enablers in Colombia's power system*

Flexibility enablers	High	Medium	Low
Interconnection capacity vs. average demand			●
Generator ramping capabilities	●		
Matching of demand with VRE generation		●	
Hydro inflow stability		●	
Strength of internal grid**	●		
Storage vs. annual demand (MWh)	●		
Geographical dispersion of VRE generation and demand			●
Minimum demand vs. VRE capacity		●	

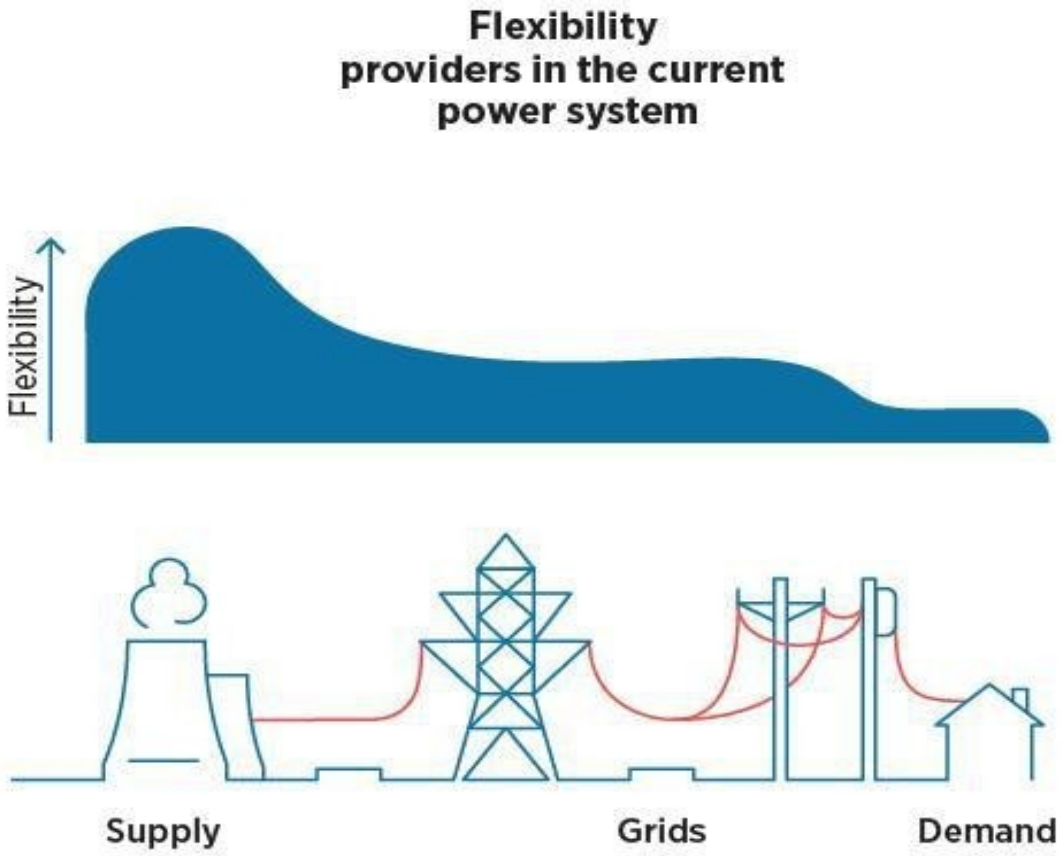
El Sistema ya es flexible. Adicionalmente:

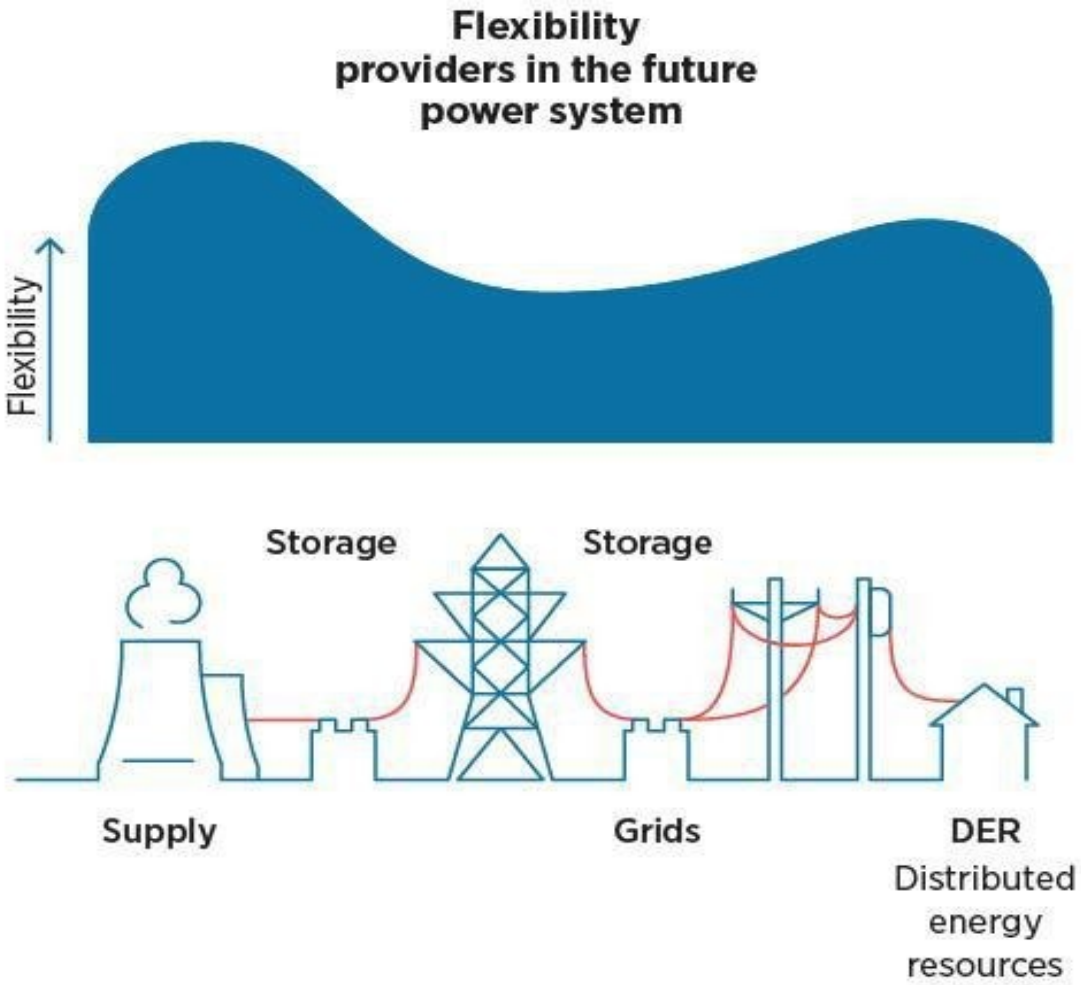
- Refuerzo de líneas de transmisión entre la Guajira y el resto del país
- Refuerzo de líneas de transmisión en la costa atlántica
- Sistemas de baterías ²Termo Zipa (7 MW) y futuro en el Atlántico (50 MW)

Baterías ya son mas baratas que plantas gas pico en USA y Australia

Fuente: https://irena.org/-/media/Files/IRENA/Agency/Publication/2018/Nov/IRENA_Columbia_FlexTool_2018.pdf

Flexibilidad a lo largo de todo el Sistema eléctrico



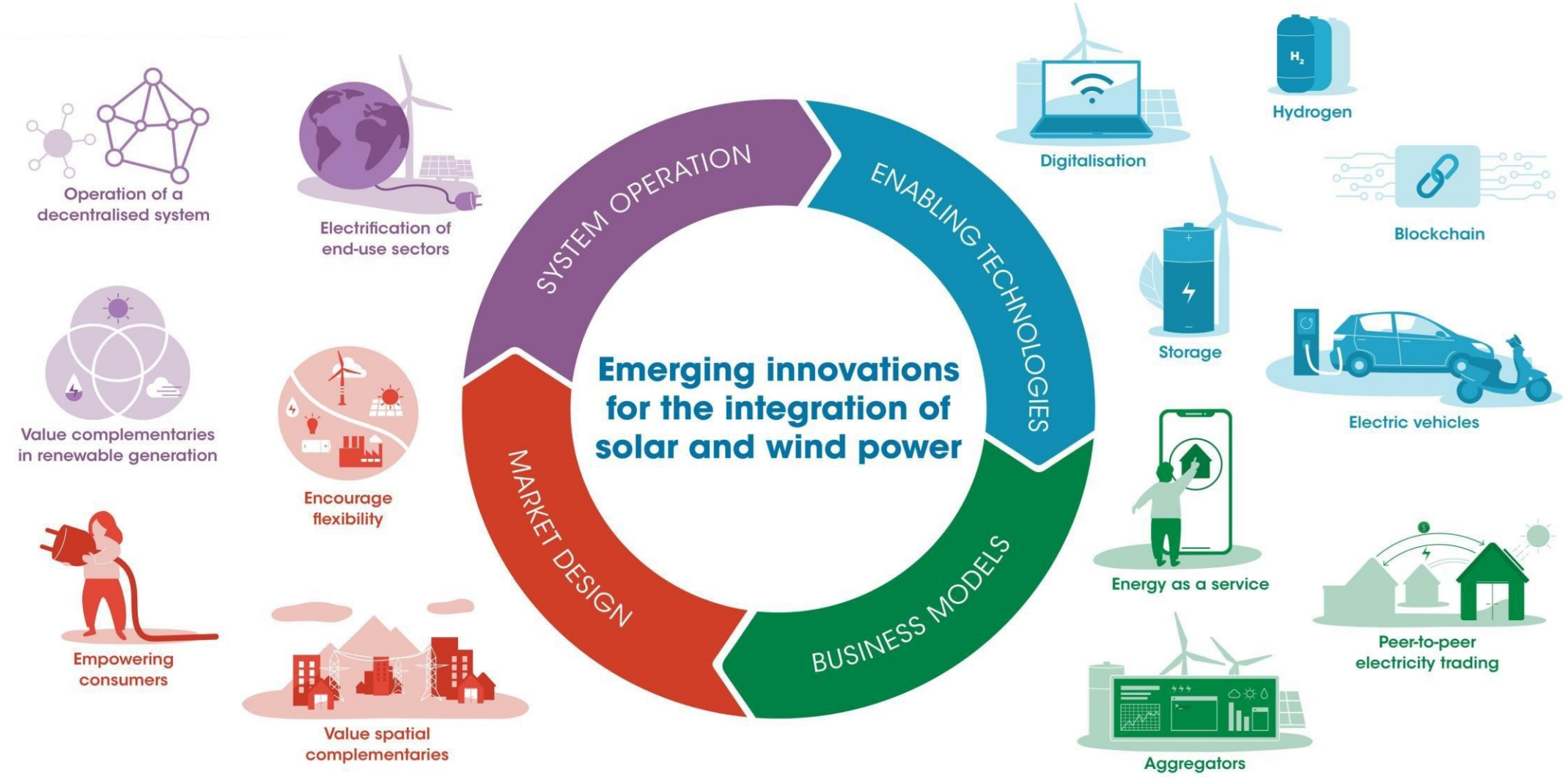


Flexibility sources: Flexible generation

Flexibility sources: Flexible generation; Regional interconnections and markets; Demand response; Storage; Power to X

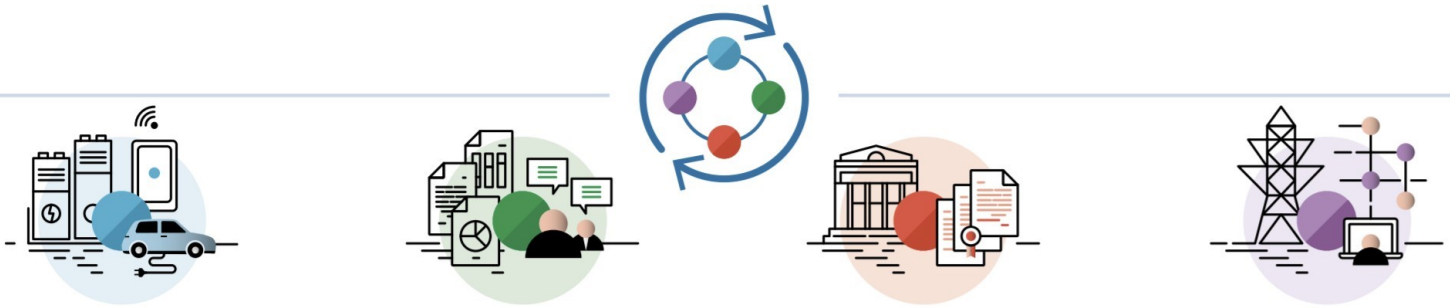
Source: IRENA (2019), Innovation landscape for a renewable-powered future: Solutions to integrate variable renewables

Innovación tiene la llave a una electrificación inteligente



Source: IRENA (2019), Innovation landscape for a renewable -powered future: Solutions to integrate variable renewables

30 Innovaciones claves para sistemas eléctricos



TECNOLOGÍAS FACILITADORAS

1	Baterías a gran escala
2	Baterías detrás del contador (“Behind the Meter”, BtM)
3	Carga inteligente de vehículos eléctricos (VE)
4	Conversión de energía renovable a calor (Renewable power-to-heat)
5	Conversión de energía renovable a hidrógeno (Power-to-hydrogen) renovable
6	Internet de las Cosas
7	Inteligencia artificial y "Big Data"
8	"Blockchain"
9	Mini red renovable
10	Súper redes
11	Flexibilidad de las centrales eléctricas convencionales

MODELOS DE NEGOCIO

12	Agregadores ("Aggregators")
13	Comercio de la electricidad "Peer2Peer"
14	La energía como servicio
15	Modelos de propiedad comunitaria
16	Modelo de pago por uso ("Pay-as-you-go")

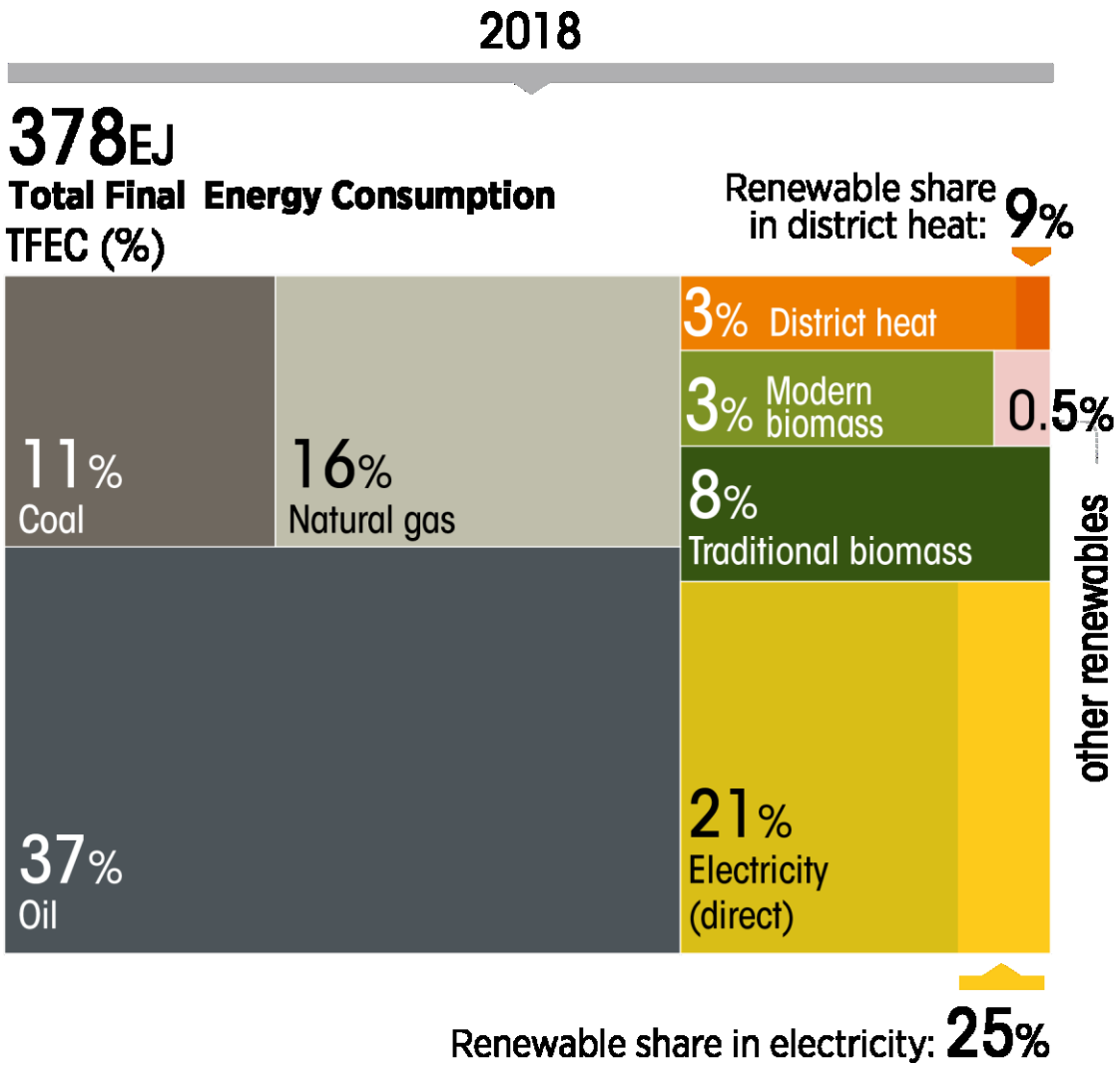
DISEÑO DE MERCADOS

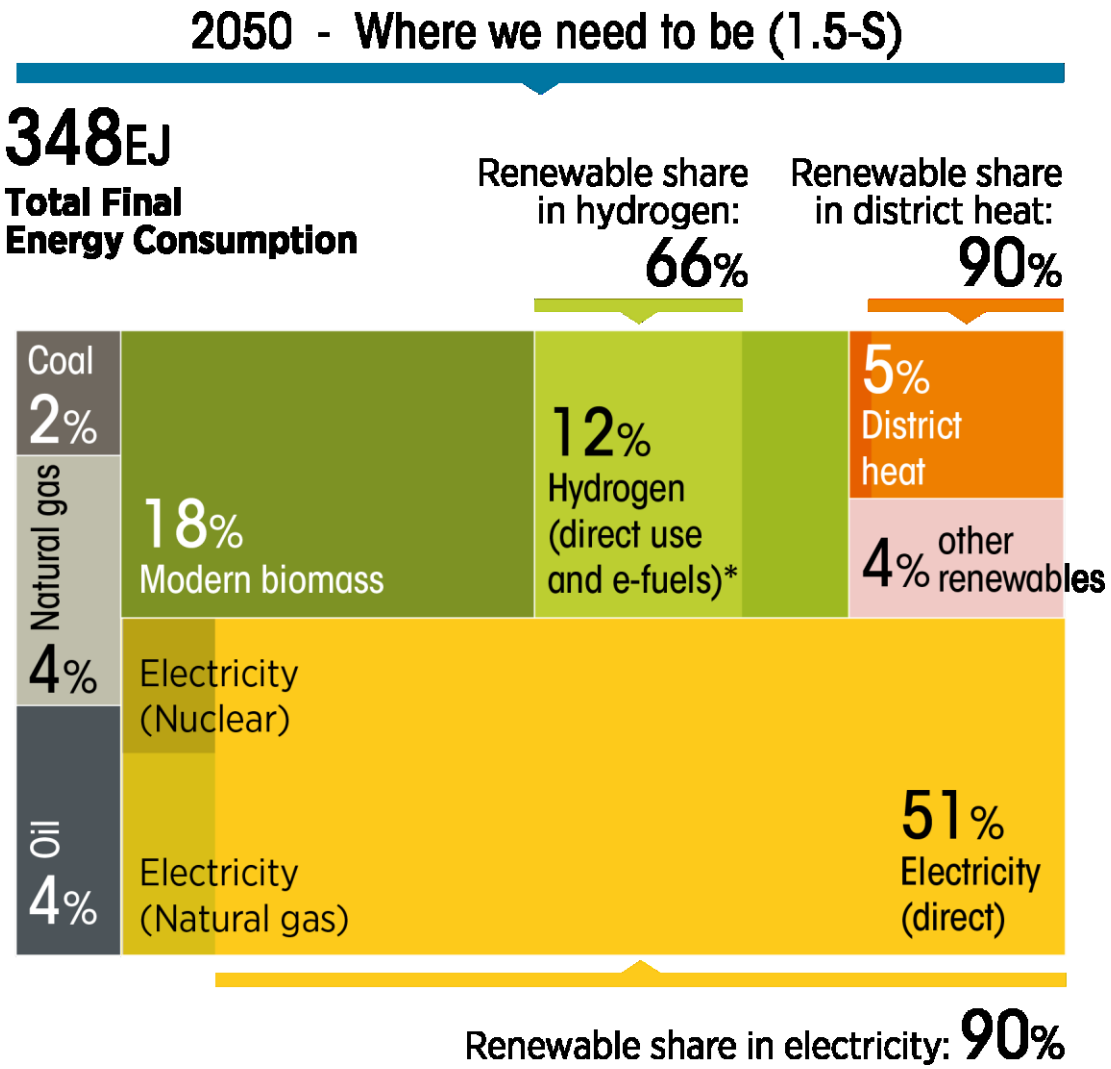
17	Aumentar la granularidad temporal en mercados eléctricos
18	Aumentar la granularidad espacial en mercados eléctricos
19	Servicios complementarios innovadores
20	Rediseñar los mercados de capacidad
21	Mercados regionales
22	Tarifas por tiempo de uso
23	Participación de los recursos energéticos distribuidos (DER) en los mercados mayoristas
24	Esquemas de facturación neta

OPERACIÓN DE SISTEMAS

25	Rol futuro de los operadores de sistemas de distribución
26	Cooperación entre operadores de los sistemas de transmisión y distribución
27	Pronóstico avanzado de generación de energía renovable variable
28	Operación innovadora de almacenamiento hidráulico por bombeo
29	Líneas virtuales de electricidad
30	Uso dinámico de líneas eléctricas (Dynamic Line Rating)

Electricidad será el Rey de los vectores energéticos





Electrificación Directa e Indirecta

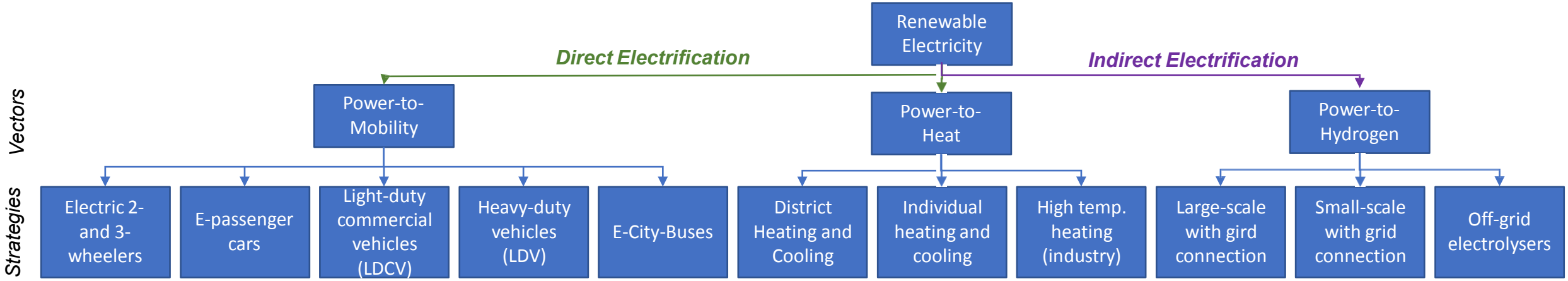
DirectElectrification

SmartElectrificatiofnor Transport

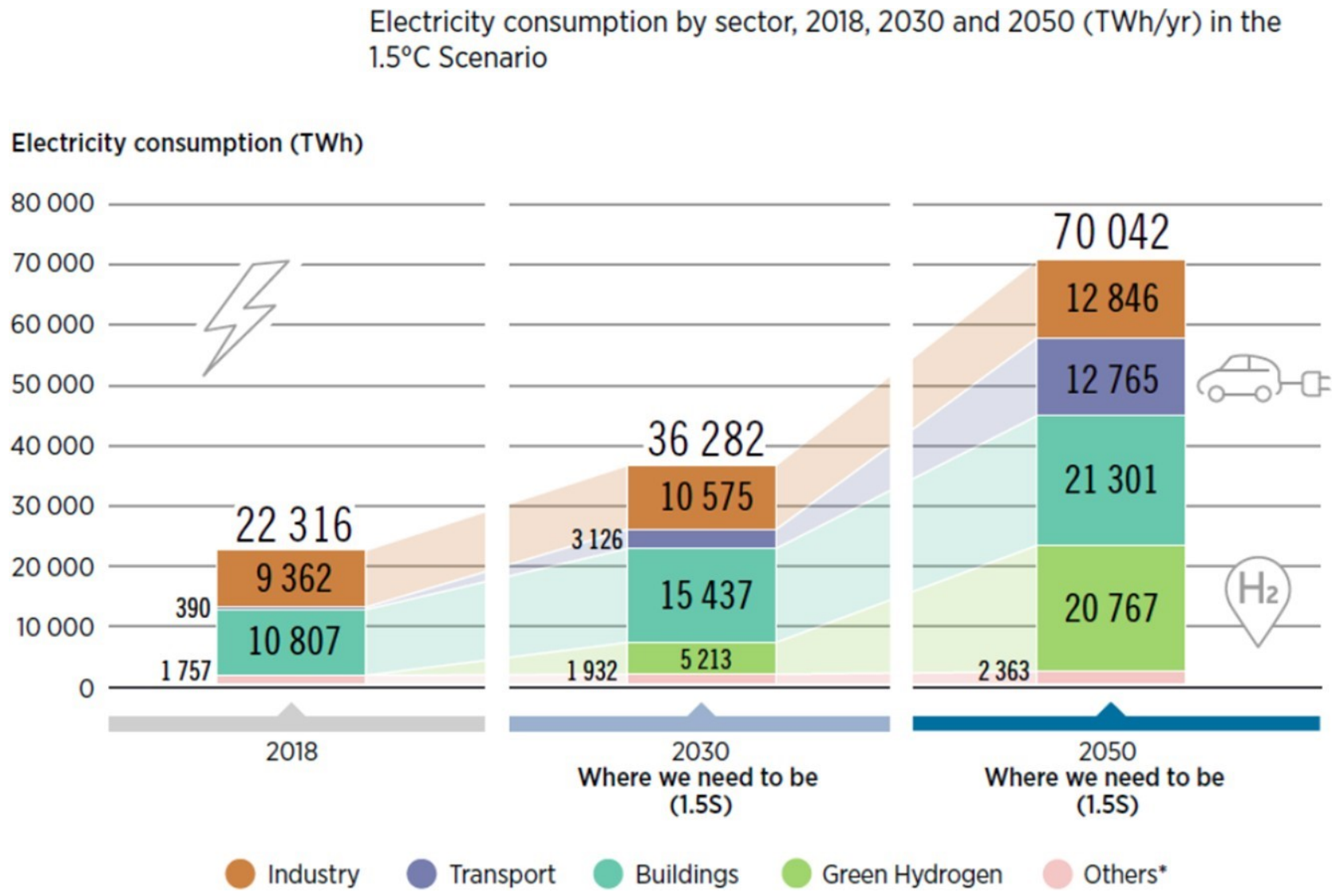
SmartElectrificatiofnor HeatingandCooling

IndirectElectrification

Smart Productionfor Hydrogen andDerivatives



El reto de la electrificación de los sectores de la demanda



Source: https://www.irena.org/publications/2021/March/World-Energy-Transition-sOutlook

Key considerations

1 Annual **Energy demand** : must come from renewables

²power system flexibility

2 Load profile: peak demand

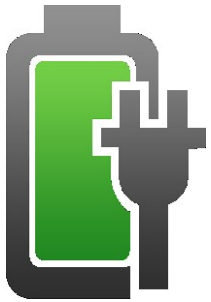
²infrastructure

3Investments in infrastructure for electrification in the same order of magnitude as RE capacity: ~ 900billion USD/year –

Smart electrification is the only option

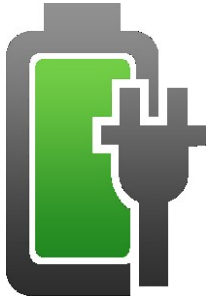
Electrificación Inteligente ²convertir nueva demanda eléctrica en fuentes de flexibilidad

Utility scale



5.5 TWh

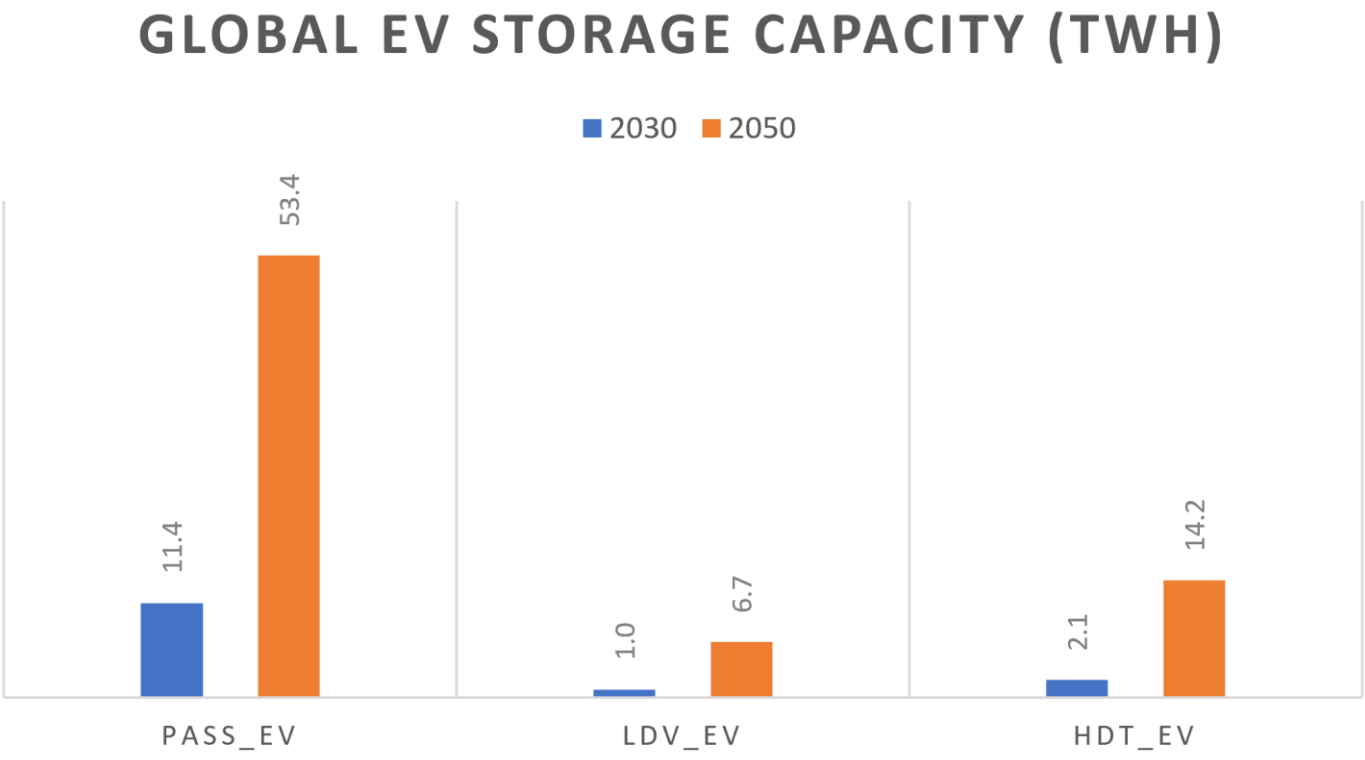
BtM Decentralised



10.8 TWh

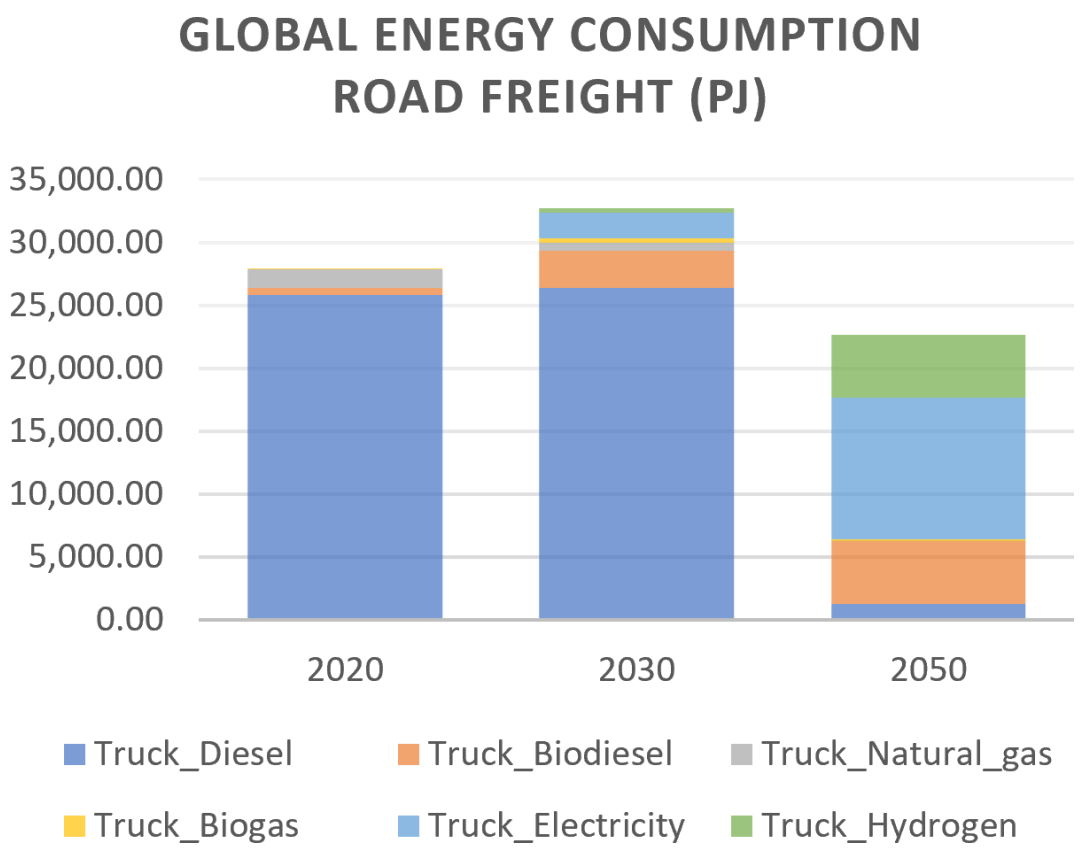
1,700 million Evs in 2050

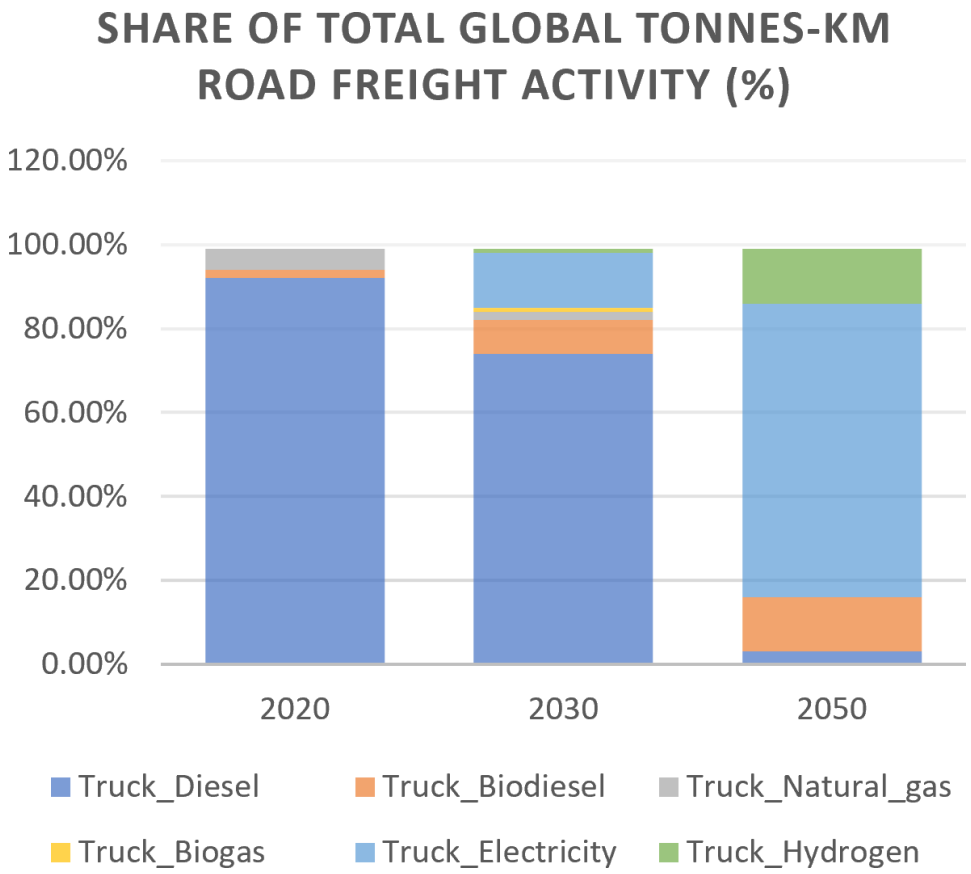
> 50 TWh (pass only)



- ③ All vehicles charge smartly either with V1G or V2G
- ③ 2/3 wheelers can only charge with V1G
- ③ For the other vehicles only 20% provide V2G (1:3 simultaneity) ~ 3 TWh, the rest V1G ~ 12 TWh

Ganancias de eficiencia gracias a electrificación directa el caso de camiones eléctricos





E-heavy duty trucks

- 2030: **9 million** e-trucks / ~3.5 TWh battery capacity
- 2050: **60 million** e-trucks / **~ 24 TWh** battery capacity (estimated stationary utility storage 11 TWh)

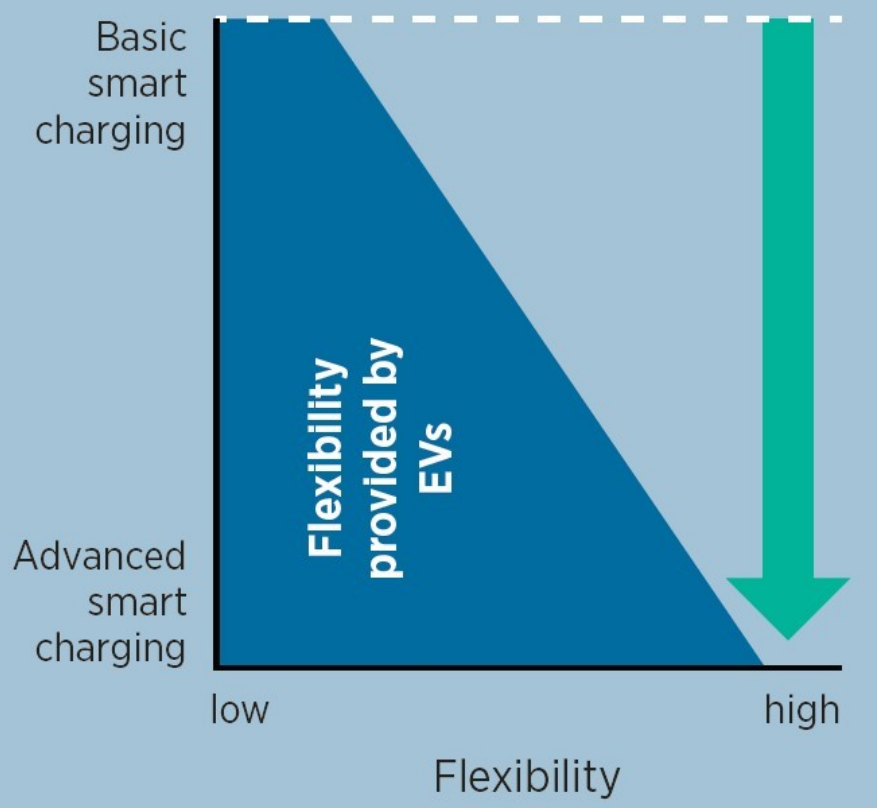
Source: https://www.irena.org/publications/2021/Jun/World-Energy-Transition-sOutlook

Carga inteligente de vehículos eléctricos

Current concepts of smart charging include

- Time-of-use pricing without automated control
- Basic controlled (on/off)
- Unidirectional controlled (V1G)
- Bidirectional controlled (V2G, V2H, V2B)
- Dynamic pricing with automated control

Smart charging enables EVs to provide grid services



Source: IRENA (2019) Innovation Outlook: Smart charging for Electric Vehicles

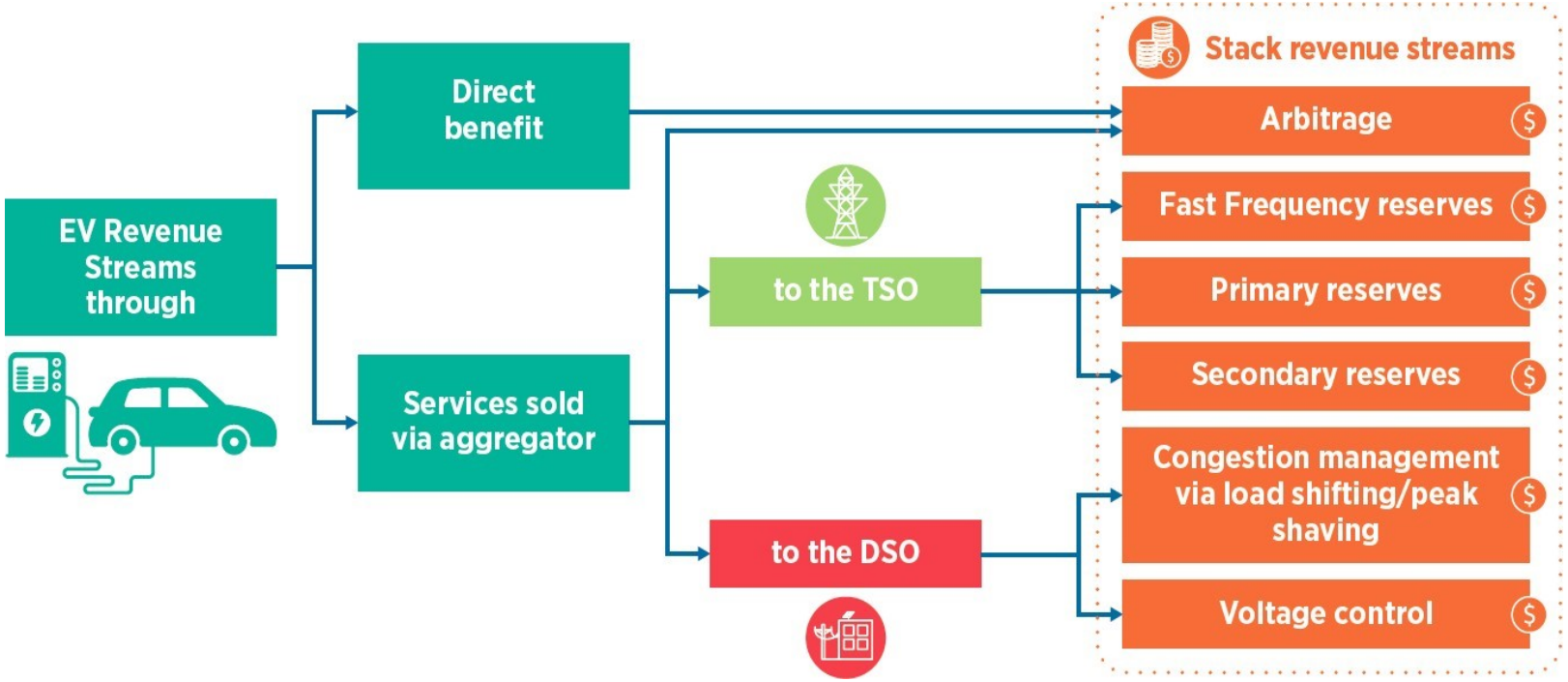
Innovación en regulación para vehículos eléctricos

Regulation:

- Time-of-use tariffs
- Need for flexibility markets at low-voltage level (e.g. congestion)
- EVs bidding multiple services in ancillary markets
- Reward performance and capacity
- Avoid double levies and fees (charging and discharging)

Businessmodels:

- Aggregator businessmodels crucial to reach trade capacity
- Consider car owner priorities – type of grid services with high revenue but also preserve car/battery ("on-call" service)



Source: IRENA (2019) Innovation Outlook: Smart charging for Electric Vehicles

Innovación para electrificación inteligente ² el caso de California

Technology & infrastructure

EVs
- 420.000 full EVs on road

Diversity and ubiquity of charging infrastructure
- 57,000 Level 2 + 4,900 DC fast (public chargers)
- 240,000 Level 2 + 10,000 DC fast (2025)

Batteries and battery recycle
- lithium-ion batteries
- ReCell Center: first advanced battery recycling R&D center

Digitalization
- Interoperability and connectivity : BMW piloting the Chargeforward System Architecture

Market design & regulations

V2G regulatory framework
- Grid codes enables V2G charging: The new Rule 21 revisions clarify that V2G-DC or V2G-AC systems can be interconnected
- Recommendation to Allow V1G and V2G to qualify for SGIP, but V1G would get less incentive compared to V2G based on permanent load shift logic

Smart charging enablement by wholesale market constructs
- V2G company Nuvve participating in California¶s wholesale energy markets to help balance the grid

Time of Use Tariffs for EVs (US$/kWh)
- Daily Peak at 0.5 (4 - 9 p.m.), Partial Peak at 0.3 (3 - 4 p.m. and 9 p.m. - 12 a.m.) and Off-Peak at 0.15 (all other hours)

California

System operation & planning

Cooperation of regulatory agencies for VGI
- The Vehicle Grid Integration Working Group that brings together CARB, CAISO, CEC and CPUC

Management of EV load to integrate renewables
- BMW Chargeforward takes into account renewables: shifting charging during the late morning hours can help with oversupply of solar generation.

Management of EV load to defer grid updates
- PG&E is purchasing distribution capacity for either generation or load (Evs can participate)

EV as a resiliency solution
- EV battery and solar as backup systems for wildfires and blackouts

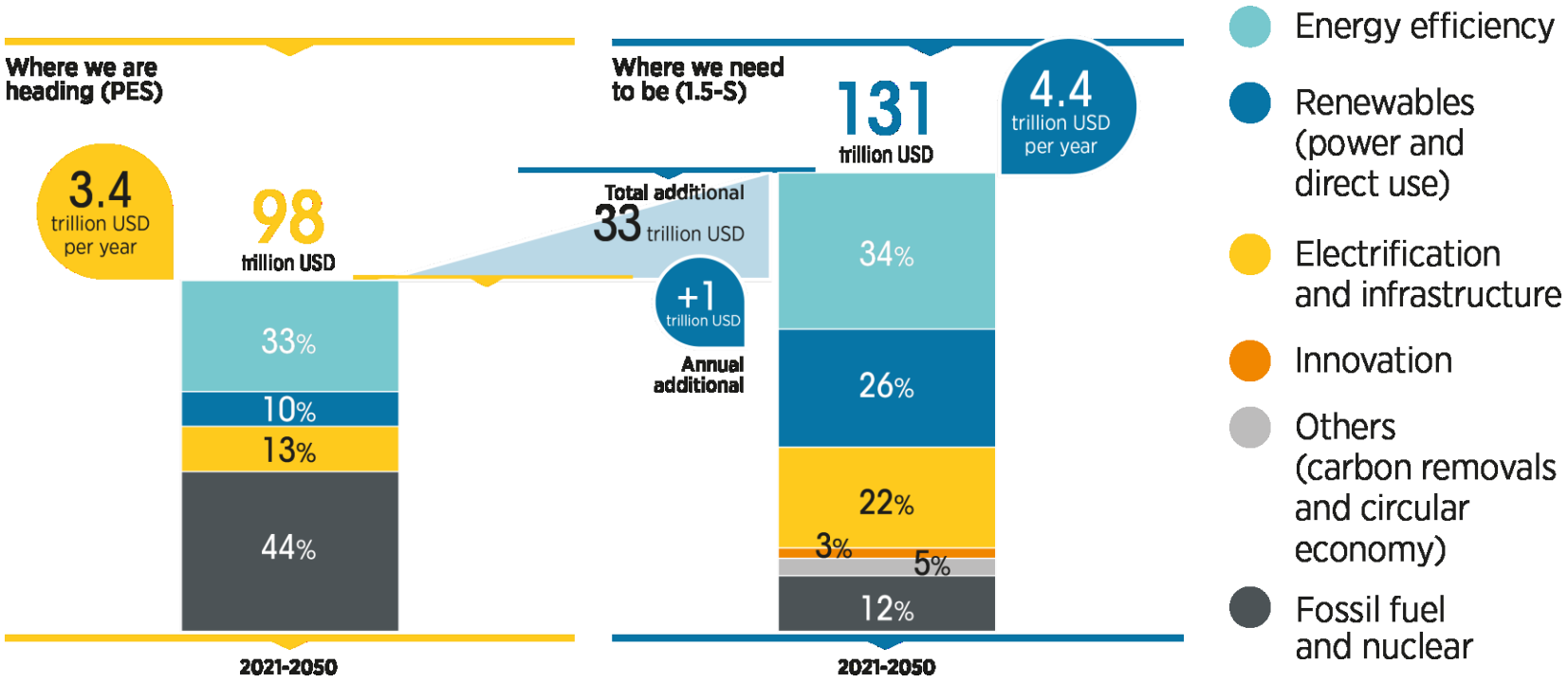
Businessmodels

EV load peak shaving
- ChargeForward vehicles can create an average of $325 in estimated grid savings annually per vehicle in California

Battery second life
- California Awards $10.8M to Reuse EV Batteries in Solar & Microgrid Projects (4 projects)

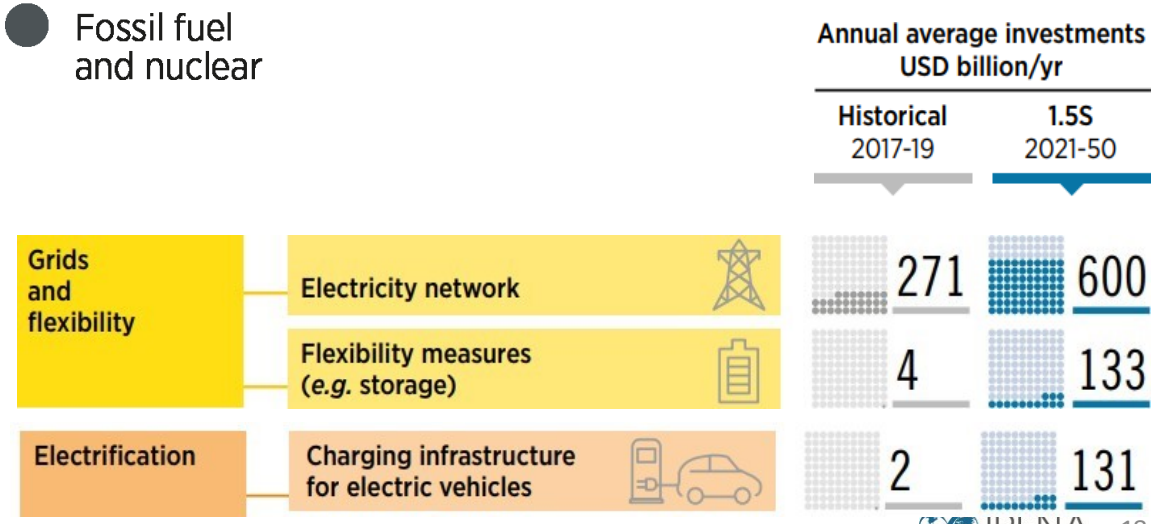
Charging stations ownership and operations
- Four community choice aggregators (CCAs) are funding $65 million in infrastructure to support the rising number of electric vehicles (EVs) in the state.

Inversiones para electrificación a nivel global



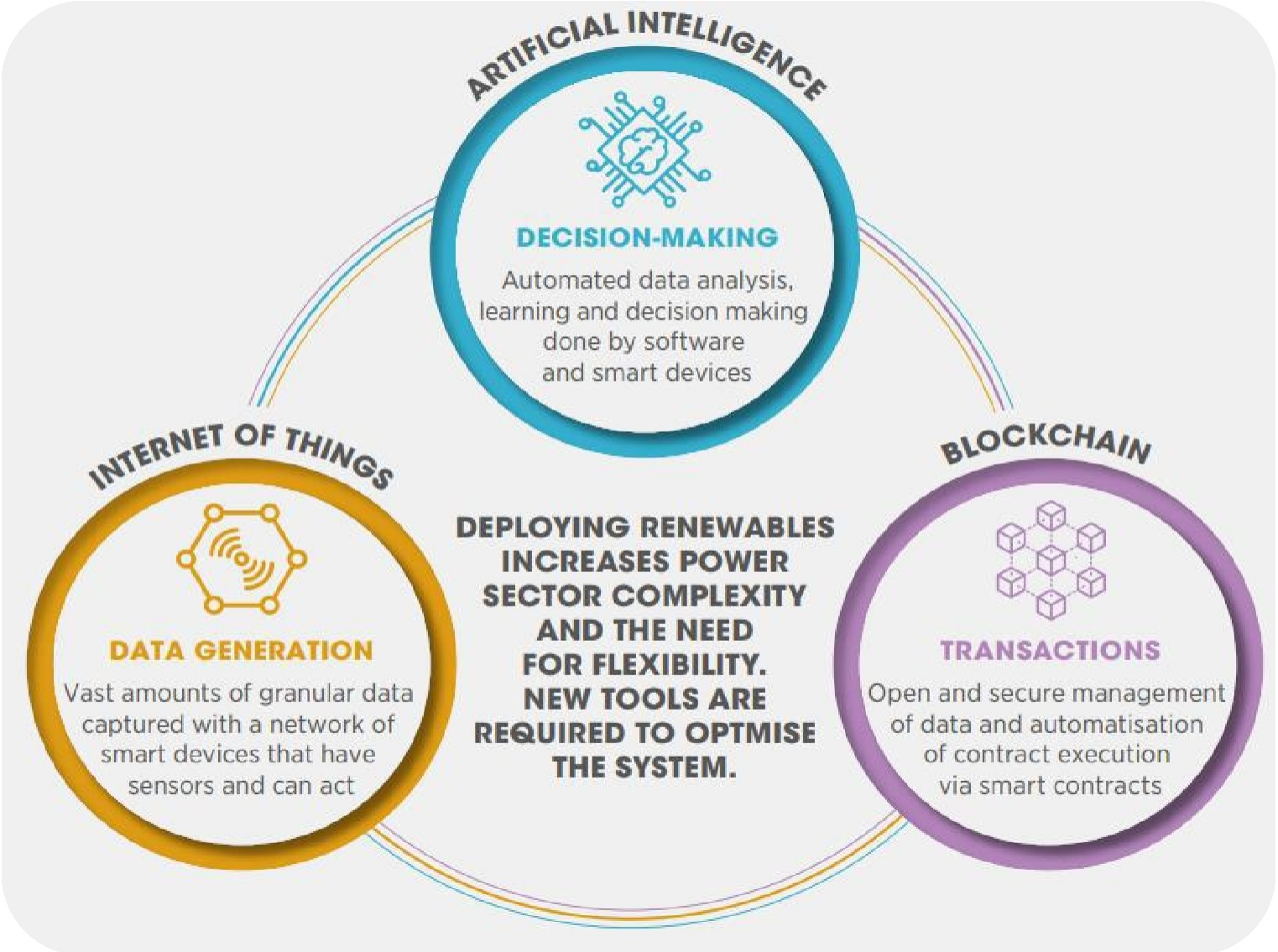
Source: IRENA World Energy Transitions Outlook (2021)

A climate-safe future calls for the scale-up and redirection of investments towards energy transition technologies, away from fossil fuels.



Source: IRENA Global Renewables Outlook (2020)

Digitalización es clave para electrificación inteligente



- **75 billion devices** could be connected worldwide by 2025
- Most IoT projects focus on **demand - side applications** (smart homes)
- Global investment in blockchain in energy markets would grow to over **6 billion USD by 2025**
- Interesting new applications in electricity markets, e.g. EUPHEMIA using **AI to integrate 25 EU day - ahead markets**
- Projects are **emerging in all continents** – EU a frontrunner
- TSOs looking into applications to **increase visibility of distributed assets** as a source of flexibility
- ***(~ 100 projects documented in IRENA·s Innovation Briefs)***

CEER Council of European Energy Regulators

IRENA International Renewable Energy Agency

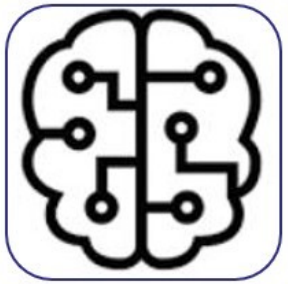
Ejemplo: carga de vehículos eléctricos en Alemania

Case study: EVs impact on Hamburg's distribution grid

Stromnetz Hamburg assessment: 9% EV share (60.000 EVs) would cause bottlenecks in 15% of the feeders in city's distribution network

Option A: Grid reinforcement solution

- Reinforcing ~ 10 000 km of 0.4 kV cable lines, replacing trasformers
- Construction works for many months, closing of roads
- Estimated investment: **20 million EUR**



Option B: Smart digital solution

- Decrease the simultaneity. All charging points need to be visible by the DSO
- A real-time communication system enables DSO to reduce charging points loads.
- Estimated Investment: **2 million EUR**

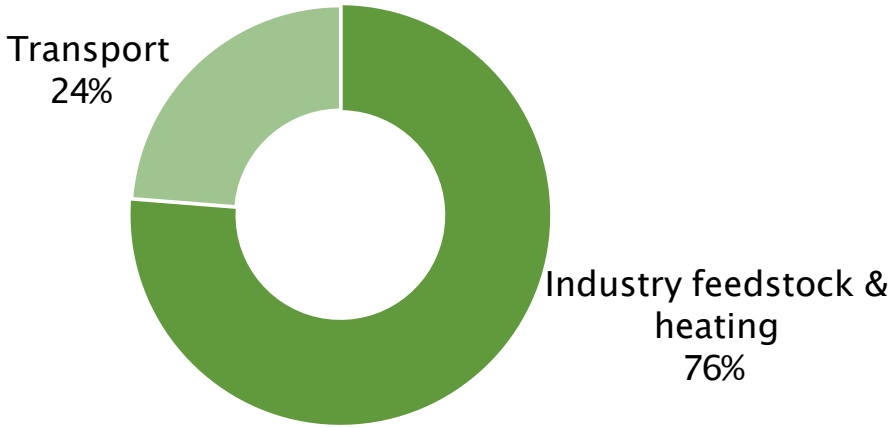
90% grid investment savings with smart solution

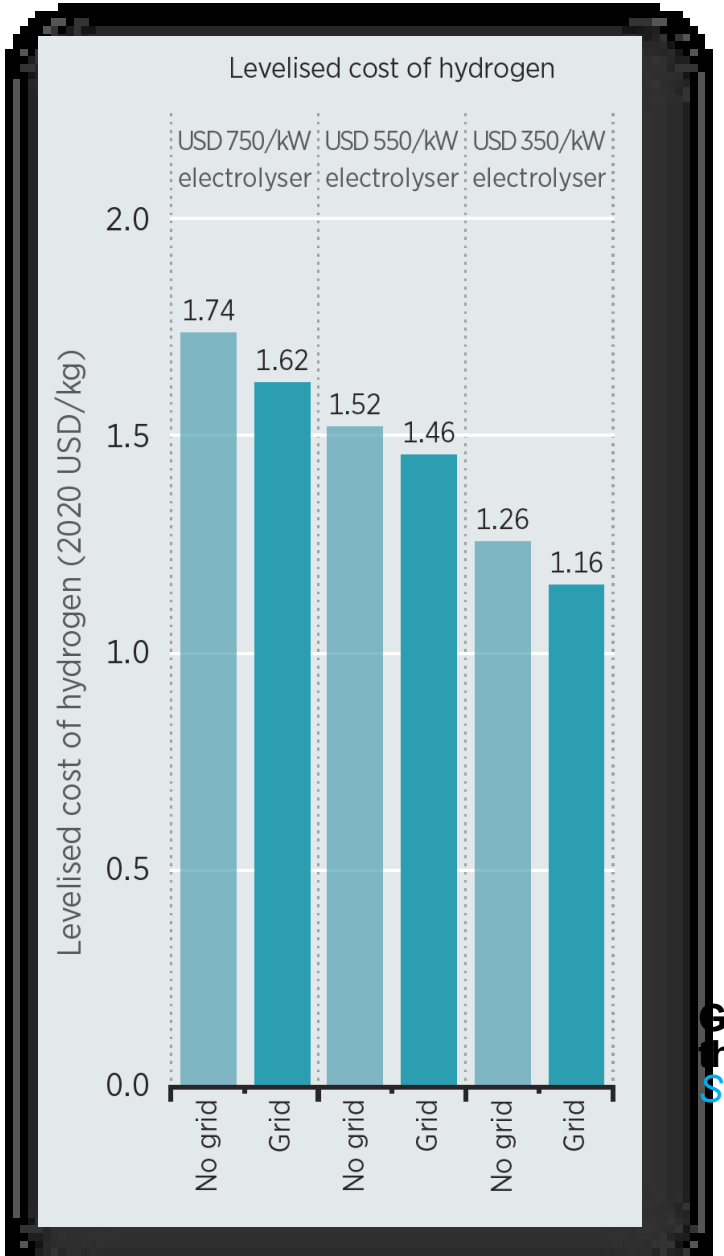
Source: IRENA (2019) Innovation Outlook: Smart charging for Electric Vehicles

Hidrogeno verde ²electrificación indirecta

By 2050, over 60% of total hydrogen will be consumed in hard-to-decarbonise sectors

Clean hydrogen consumption in HTDS in 2050 (1.5C Scenario)





Green hydrogen produced in the dessert
Saudi Arabia (PV 2 USDct/kWh)

Source: https://www.irena.org/publications/2021/Jun/Renewable-Power-Costs-in-2020

Comercio global de hidrógeno verde y sus derivados

Location of facilities: close to demand or low cost RE electricity?

Table 1: Location choice economics

	Current world production [Mt/yr]	Product price [USD/t]	Green product price 2030 [USD/t]	Shipping cost (indicative) [USD/t]	Energy cost benefit of relocation [USD/t]
Primary aluminium	65	2500	2500	70-100	425
Ammonia	200	250-400	600	100	340
Cement	2900	20	100	50	20
Iron	1389	300-500	400-600	15-50	115
Jet fuel	250	300-500	1000	50	600
Methanol	100	410-520	600	100	375
Hydrogen	120	800	1500	1500	1500

Note: Energy cost benefits have been calculated by multiplying energy intensity with cost savings per unit of energy. Shipping cost data were taken from recent market surveys. These are indicative as they tend to fluctuate, strongly based on the supply and demand balance. Energy cost benefit 3 ct/kWh for electricity, 5 USD/GJ for thermal energy, 1.5 USD/kg for hydrogen

Source: IRENA analysis

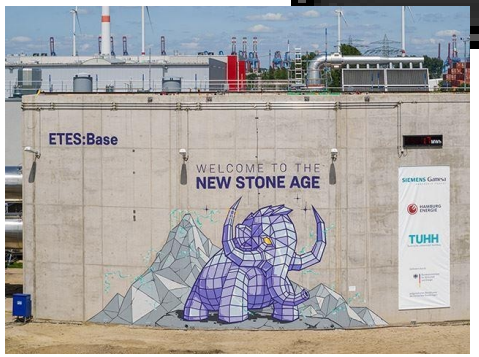
IRENACollaborative Framework Green Hydrogen

- 60 countries engaged
- Exchange of knowledge between governments and industryon green H2 trade

https://www.irena.org/collaborativeframeworks/Green-Hydrogen

Source: https://energypost.eu/eus-carbon -border-adjustment-mechanism -lacks-the-detail-to-drive-industrys-relocation -near -clean -energy

Almacenamiento térmico apoyando electrificación

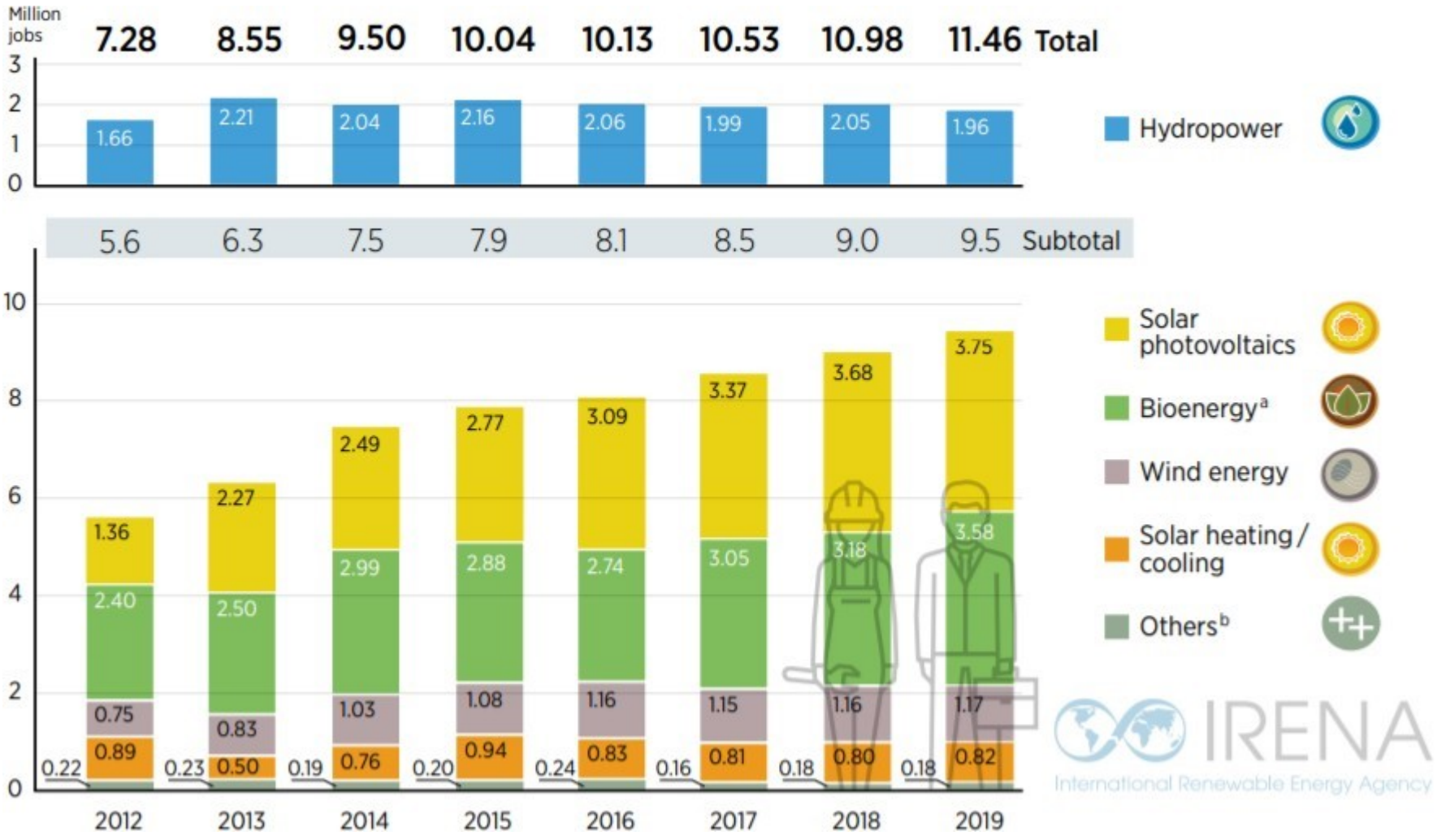


Example: Solid state TES with wind power

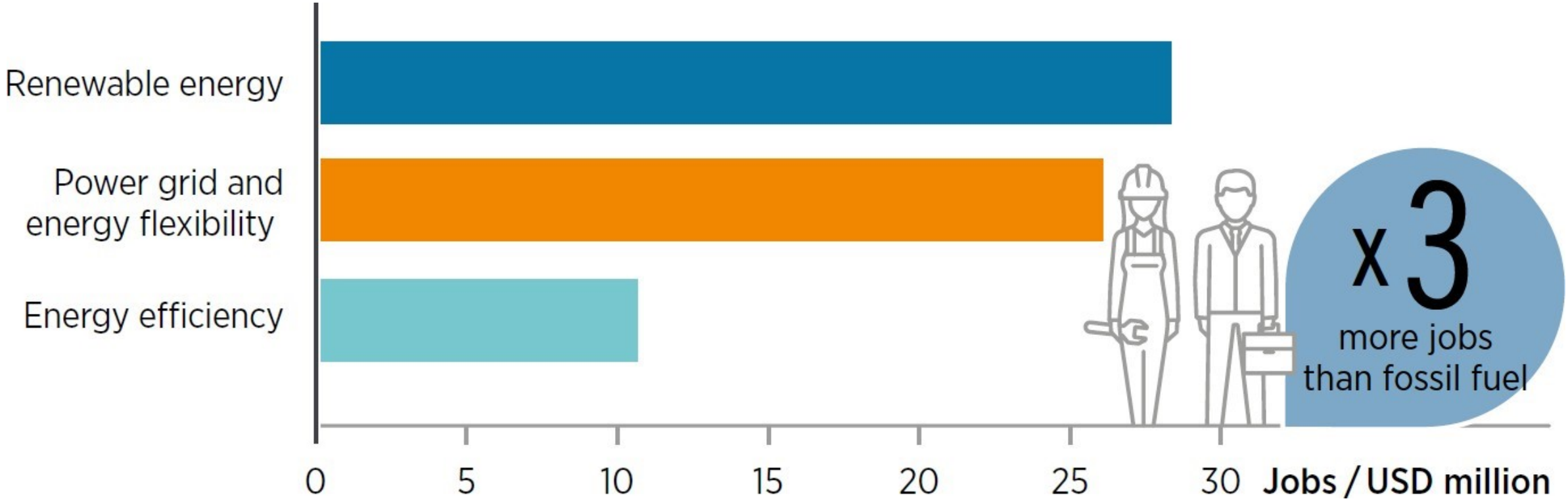
- Siemens-Gamesa commissioned in 2019 Hamburg, Germany
- Over 1,000 tons of rock provide thermal storage capacity of 130 MWh of electric energy at rated charging temperatures of 750°C
- The heat is re-converted into electricity through steam – electricity output 1.5 MW

Source: IRENA (2020), Innovation Outlook: Thermal Energy Storage

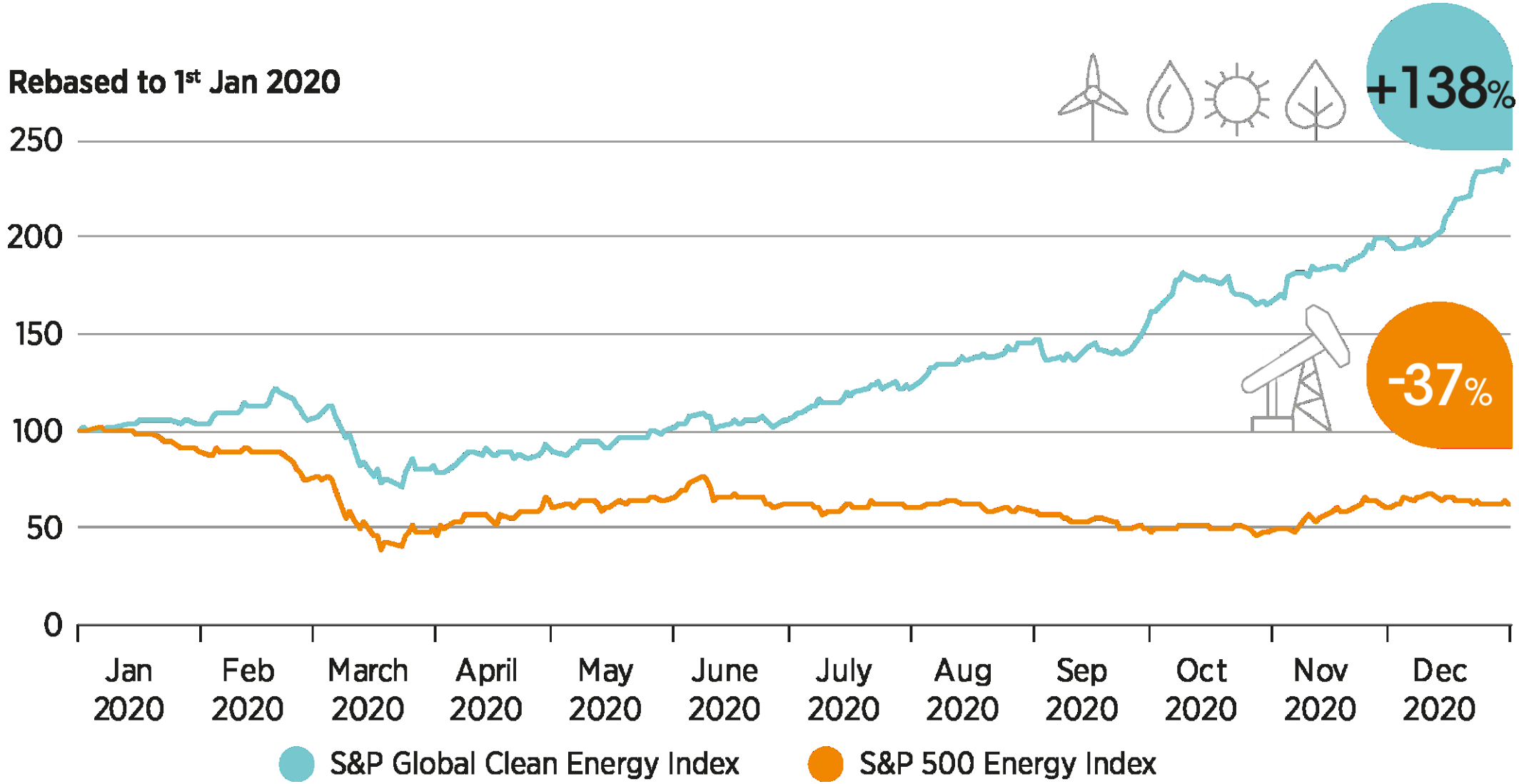
Renovables y creación de empleo



Intensidad empleos creados por las renovables



Tendencia actual en mercados financieros



Inversionistas y mercados financieros están reaccionando a la transición energética

IRENA Coalition for Action-Colombia mercado emergente atractivo

- > 5 GW de ERV a 2030
- Inversiones en solar FV, eólica y almacenamiento hidráulico
- Colombia como líder regional [2] Iniciativa RELAC llama al 70% de generación eléctrica en la región de renovables

- Considerar nuevos diseños de mercado y marcos regulatorios para energías renovables variables
- Subastas que consideren una distribución de riesgos balanceados y acuerdos de compra de electricidad ajustados a normas internacionales
- Estrategia de largo plazo para desarrollos de redes eléctricas
- Fortalecer la inclusión de aspectos socio-económicos con enfoque en comunidades locales en los proyector renovables

Fuente: https://coalition.irena.org/-/media/Files/IRENA/Coalition-for-Action/Publication/Scaling-up-Renewable -Energy-Investment-in-Emerging-Markets/IRENA-Coalition-for-Action_Colombia_ 2020.pdf?la=en&hash=B1D9C482718D22C5E3D7BEF32A4C8B5767D14833

WORLD ENERGY TRANSITIONS OUTLOOK

1.5°C Pathway

Gracias!

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