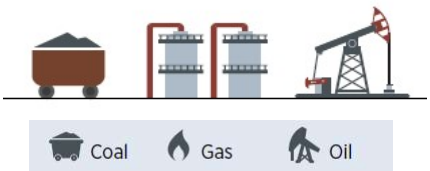
Topic 4: Energy - Transition to Renewable Energy

Dr. Supawan Saelim

EE375 - Class lecture

What is Renewable Energy?

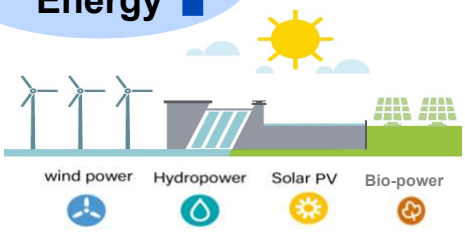
Fossil Fuels



- A one time resource (Projected to be depleted in the next 50 to 100 years)
- Global warming and air pollution

Energy Transition

Renewable Energy



- Replenish natural resources
- Emits no or low emissions
- Job Creations

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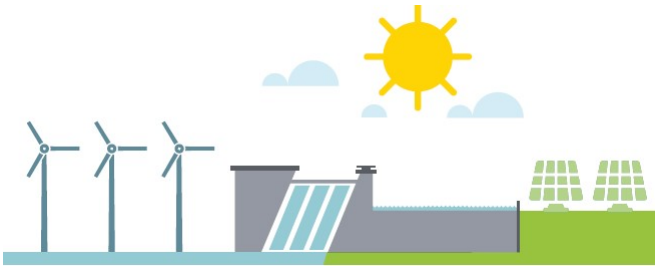
1. Global Renewable Energy Status and Trends

- Current share of renewable energy
- Increasing new annual power generation from renewable energy
- Historical trends of renewable energy shares in the power sector
- Declining costs of renewable power
- Increasing Renewable Energy Employment



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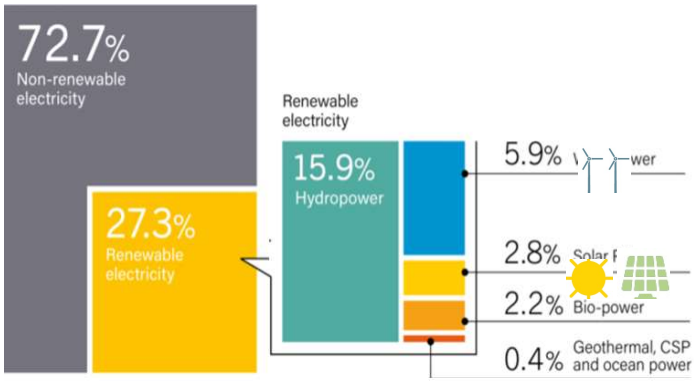
Renewable Energy Share of Global Electricity Production in 2019



POWER GW	2019
Renewable power capacity (including hydropower)	2,588
Renewable power capacity (not including hydropower)	1,437
Hydropower capacity[2]	1,150
Wind power capacity	651
Solar PV capacity[3]	627
Bio-power capacity	139
Geothermal power capacity	13.9
Concentrating solar thermal power (CSP) capacity	6.2
Ocean power capacity	0.5

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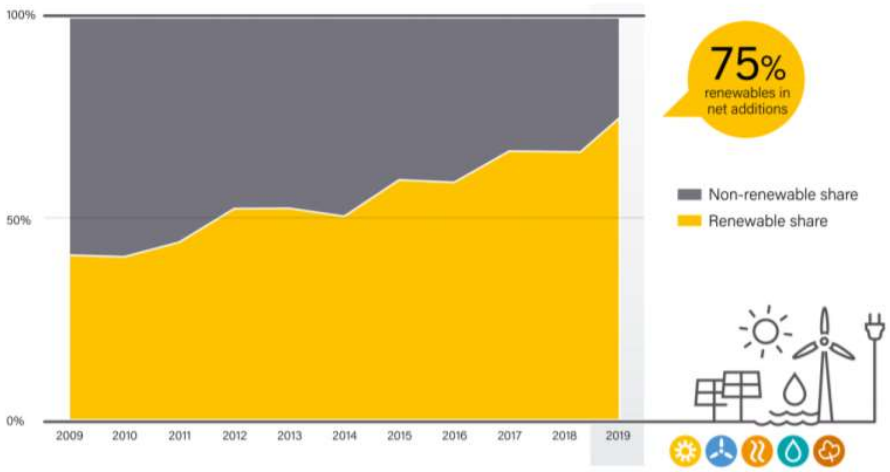
Increase of Renewables in Net Additions of Power Generation Capacity, 2009-2019



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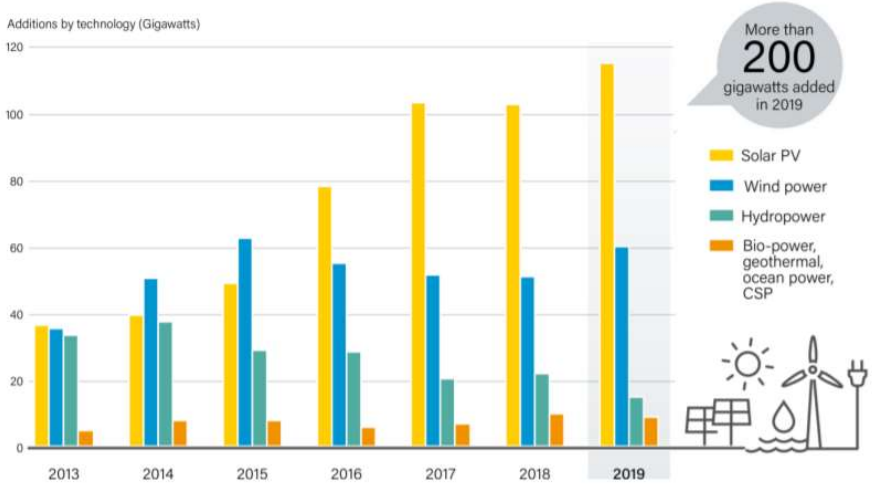
Annual Additions of Renewable Power by Technology, 2009-2019



Additions by technology in 2019:

Solar: 115 GW

Wind: 60 GW

Hydropower: 16 GW

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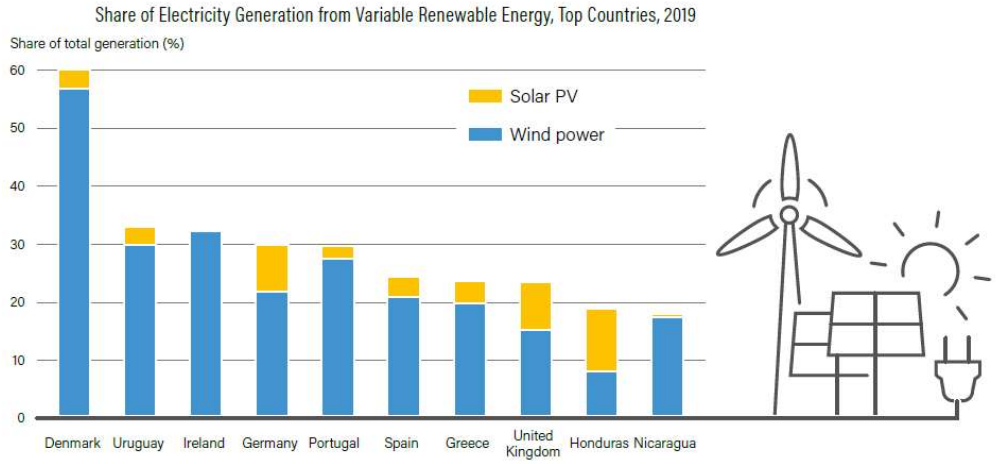
Countries with High Share of Renewables



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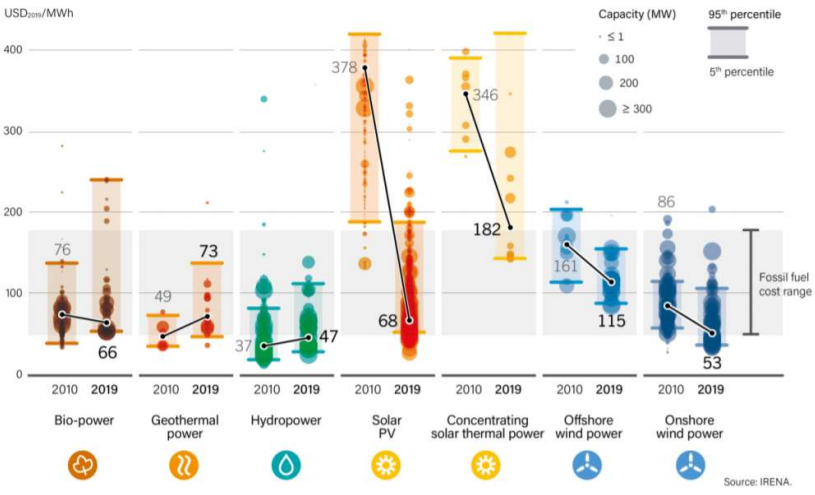
Declining Costs of Renewable Power Generation



Note: Global levelised cost of electricity (LCOE) from newly commissioned, utility-scale renewable power generation technologies, 2010 and 2019

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Increasing Renewable Energy Employment

GLOBAL RENEWABLE ENERGY EMPLOYMENT BY TECHNOLOGY, 2012-2019

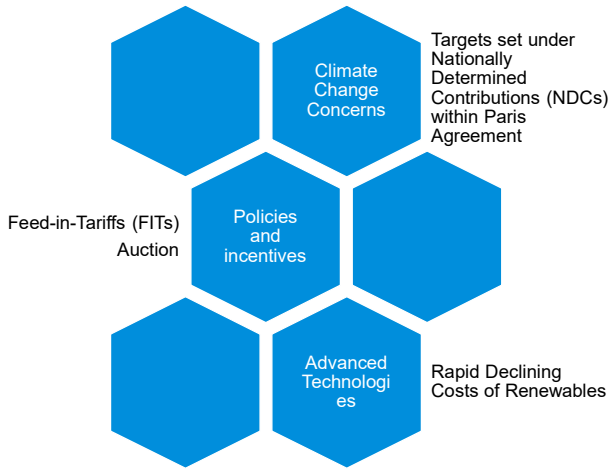
KEY NUMBERS

11.5 million renewable energy jobs in 2019

38% in China

3.8 million in the solar PV industry

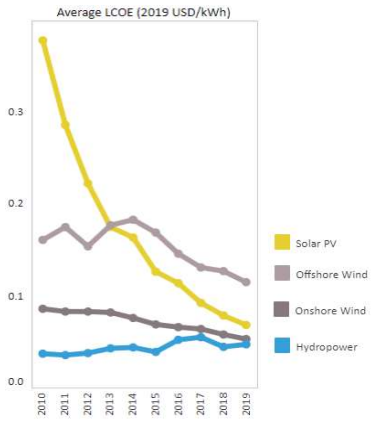
2. Drivers of Renewable Energy Growth



Targets set under Nationally Determined Contributions (NDCs) within Paris Agreement

Feed-in-Tariffs (FITs) Auction

Rapid Declining Costs of Renewables



Renewable Energy Supporting Policies and Incentives

ASEAN countries		RE Targets	FIT	Self-consumption scheme	Competitive Bidding (or Auction)	Tax incentive	Soft loan	Capital subsidy	Tradable RECs
BRUNEI		✓							
INDONESIA		✓	✓	✓	✓	✓	✓		
MALAYSIA		✓	✓	✓	✓	✓	✓		
MYANMAR		✓				✓			
PHILIPPINES		✓	✓	✓		✓			✓
SINGAPORE		✓			✓	✓			
LM Countries	CAMBODIA				✓	✓			
	LAO PDR	✓				✓			
	THAILAND	✓	✓	✓	✓	✓	✓	✓	
	VIETNAM	✓	✓	✓		✓			

Note: ✓ means the RE targets or incentives or auction has been implemented in the country.
Source: USAID Clean Power Asia data collection

What is FITs

- FITs offers a guaranteed purchasing price for a specified period of time.
- For example, a fixed tariff is set for the purchase rate of electricity at a certain constant level which is independent from the fluctuation of market price for electricity throughout the support duration (e.g. 20 years)

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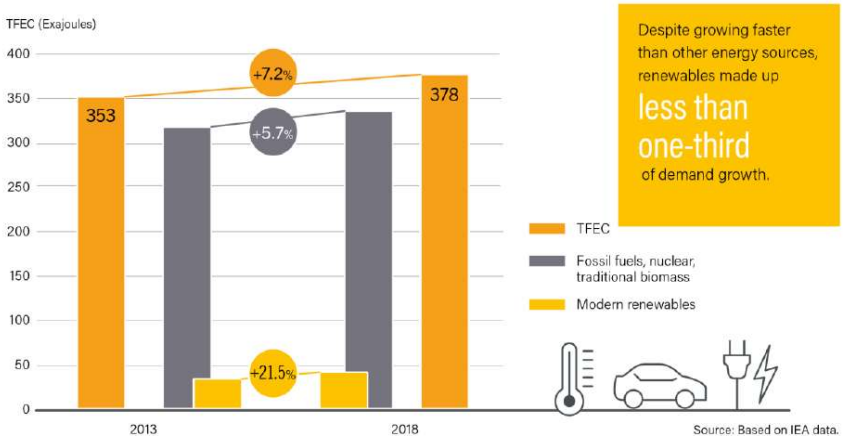
Renewable Energy are Growing Fast.. But not Fast Enough

Estimated Global Growth in Renewable Energy Compared to Total Final Energy Consumption, 2013-2018



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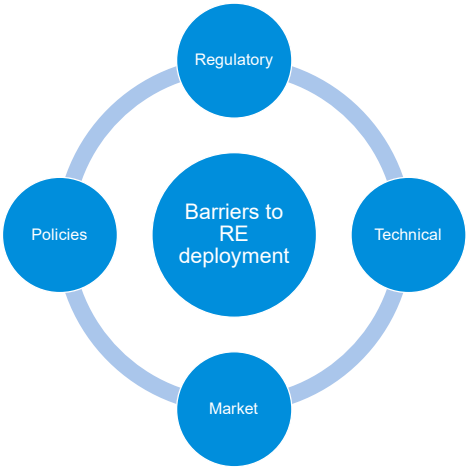
Barriers for RE Development



Regulatory barriers

- Insufficient legal framework for independent power producers
- Restrictions on siting, construction, transmission access
- Grid interconnection requirement

Policy barriers

- Subsidies to fossil fuels
- Unfavorable pricing rule

Market barriers

- Lack of experience, technical and commercial skills
- Perceived technology performance uncertainties and risk

Technical barriers

- Integrating high penetration of VRE to the grid

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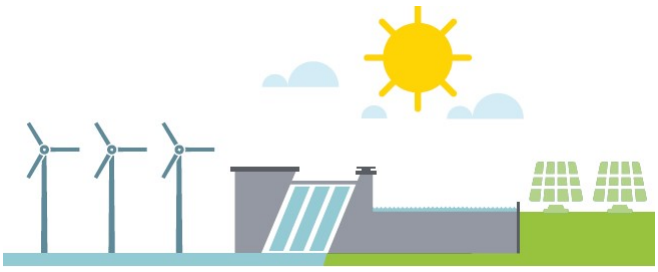
4. Global Renewable Energy Outlook

- Key indicators to global renewables outlook in 2050
- Outlook for Transforming Energy Scenario to achieve climate goals
- Global Socio-economic Impact of Transformation Energy Scenario



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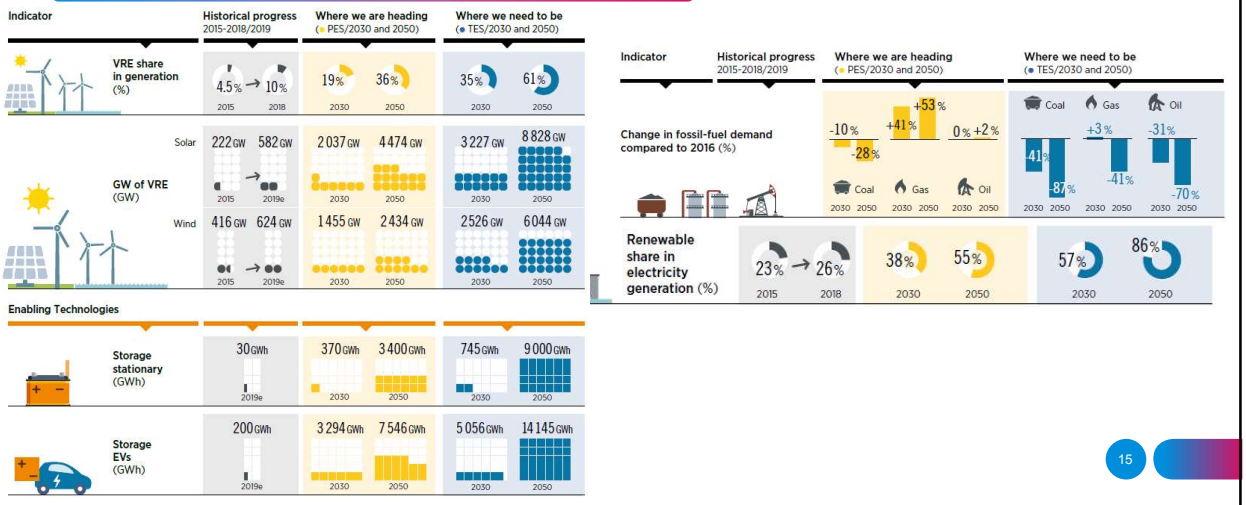
Global Renewables Outlook: Key indicators



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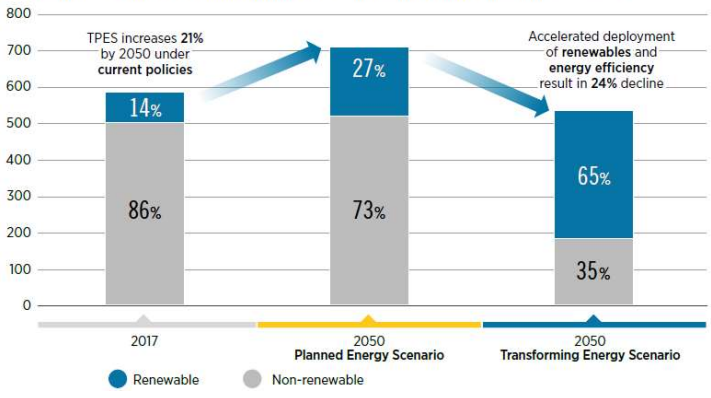
Global Renewable Outlook: Transforming Energy Scenario to achieve climate goals

To meet agreed global climate goals, renewables would need to provide two-thirds of the world's energy supply

Total primary energy supply, renewable and non-renewable share, for the Planned Energy Scenario and the Transforming Energy Scenario, 2017, 2050



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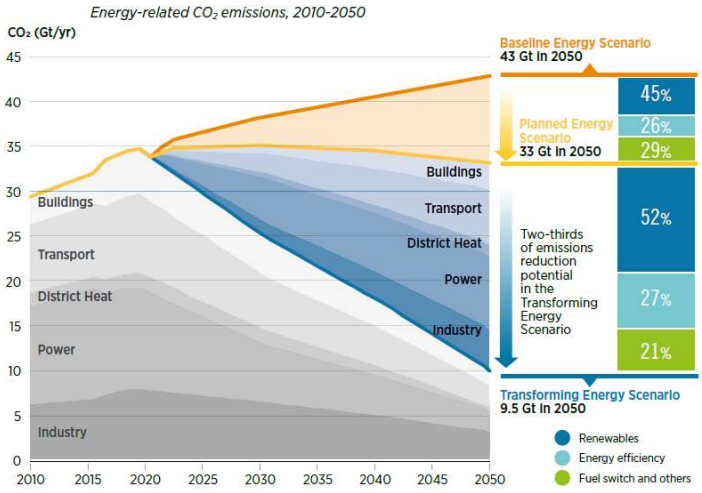
Emission Reductions under Transforming Energy Scenario



The **"Planned Energy Scenario (PES)"** is the primary reference case for this study, providing a perspective on energy system developments based on governments' current energy plans and other planned targets and policies (as of 2019), including Nationally Determined Contributions under the Paris Agreement unless the country has more recent climate and energy targets or plans.

The **"Transforming Energy Scenario (TES)"** describes an ambitious, yet realistic, energy transformation pathway based largely on renewable energy sources and steadily improved energy efficiency (though not limited exclusively to these technologies). This would set the energy system on the path needed to keep the rise in global temperatures to well below 2 degree Celsius (°C) and towards 1.5°C during this century.

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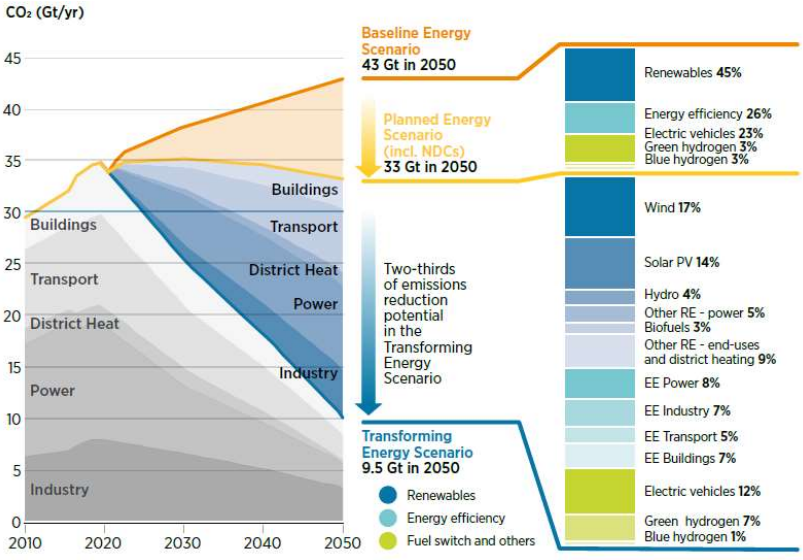
Emission Reductions under Transforming Energy Scenario, by technologies



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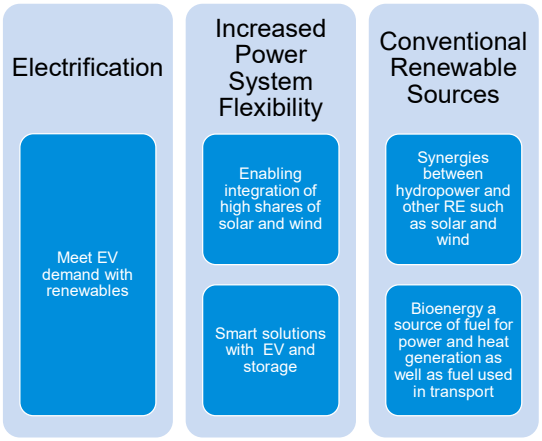
Energy Transformation Development:



TRANSFORMATIVE ENERGY DEVELOPMENTS

The energy sector has started changing in promising ways, with widespread adoption of renewables and related technologies boding well for a sustainable future. Renewable technologies are dominating the global market for new power generation capacity. Solar PV and wind are increasingly the cheapest source of electricity in many markets, and most renewable power sources will be fully cost competitive within the next decade (IRENA, 2019c).

Renewable power generation is now growing faster than overall power demand. A new milestone was reached in 2019 when renewable electricity generation increased by more than the increase in electricity demand, while fossil-fuel electricity generation decreased. This is the first time in decades that fossil-fuel-based generation declined when overall electricity generation increased (Kåberger, 2019).

The electrification of transport is showing early signs of disruptive acceleration. Progress in accelerating the transition is seen in the rapid cost reductions of solar PV and wind (including offshore), how key enabling technologies such as batteries and electric vehicles are experiencing rapid reductions in costs, and how green hydrogen is viewed as a potential game changer.

Yet renewables are growing too slowly in major energy-consuming sectors like buildings and industry. Deployment in these areas remains well below the levels needed to create a climate-safe energy system. Slowing progress in energy efficiency and biofuels development must be turned around quickly.

The share of modern renewable energy in global final energy consumption has increased only slightly since 2010, staying around a threshold of about 10%.[1] In simple terms, while renewables are increasing, so is energy demand. In the Planned Energy Scenario, the share of modern renewable energy in final energy supply would increase to 17% by 2030 and 25% by 2050. In the Transforming Energy Scenario, this share would increase to 28% by 2030 and 66% by 2050. Therefore, the share would need to increase six-fold compared to today, and two-and-a-half times compared to the Planned Energy Scenario.

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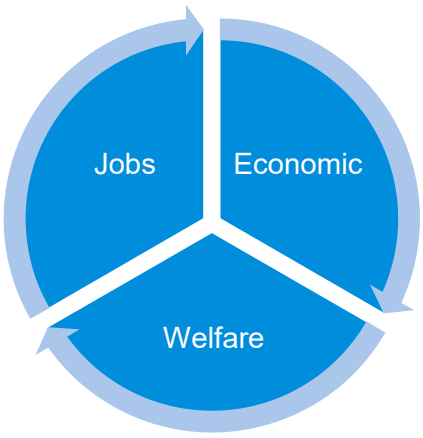
Global Socio-Economic Impact



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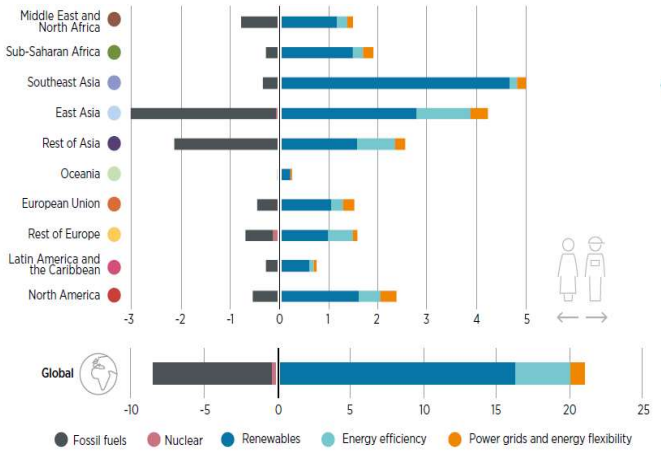
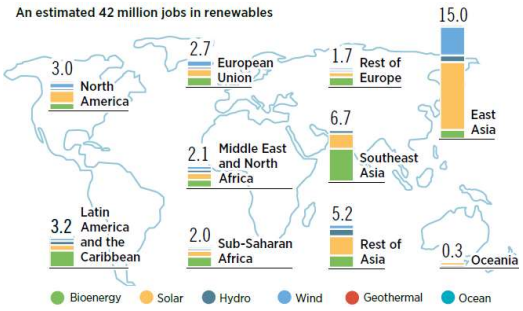
Increase Jobs from Renewables





ผลกระทบต่อการจ้างงาน:
จะมีการจ้างงานเพิ่มขึ้นในโดยเฉพาะในภูมิภาคเอเชียตะวันออกเฉียงใต้

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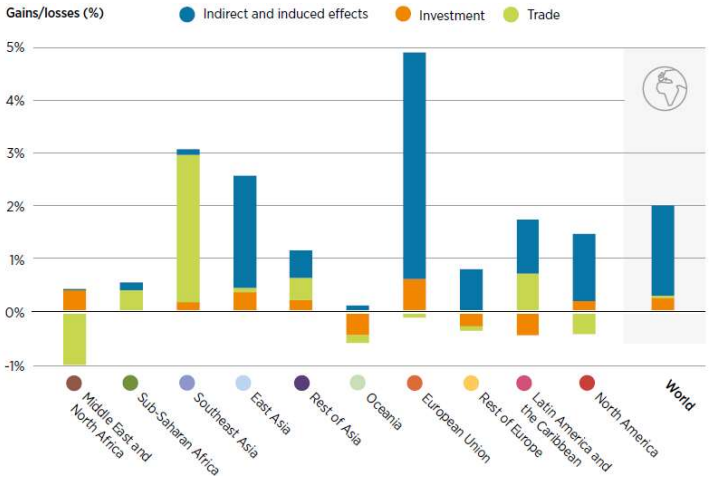
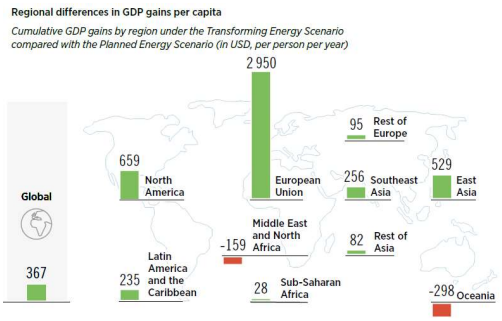
GDP Gains under Transforming Energy Scenario





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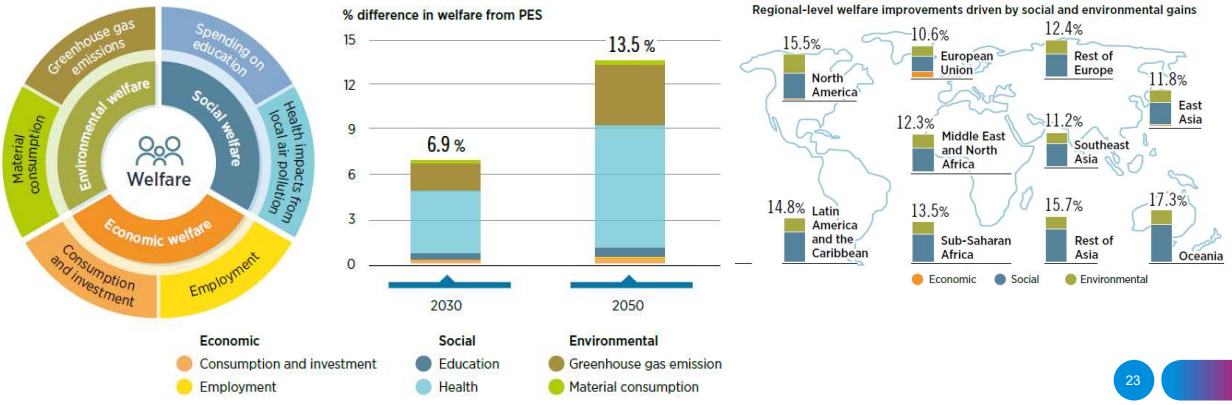
Welfare Gains from improved economic, social and environmental

Welfare gains: Influenced by health benefits and emission reduction

Global welfare indicator under the Transforming Energy Scenario in 2030 and 2050



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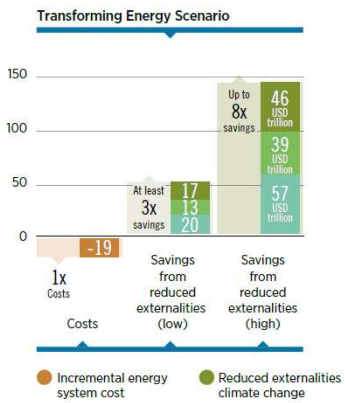
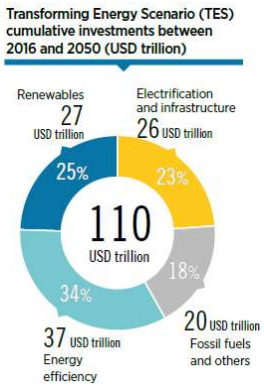
Benefits, costs and investments

The energy transition: Benefits compared to costs

Cumulative system costs and savings from reduced externalities for Transforming Energy Scenario for the period to 2050, and DDP for the period to 2060 (USD trillion)





A climate-safe future calls for the scale-up, and redirection, of investment to clean energy technologies. Fossil-fuel investments need to be shifted to renewables and energy efficiency instead, while subsidies to fossil fuels must be phased out. Overall, total investment in the energy system in the Transforming Energy Scenario would need to reach USD 110 trillion by 2050, or around 2% of average annual GDP over the period (see Figure S.8). Of that total, over 80% needs to be invested in renewables, energy efficiency, end-use electrification, and power grids and flexibility. If viewed in annual terms, USD 3.2 trillion needs to be invested in the global energy system every year to 2050. That compares to recent historical investment (2014-2018) in the energy system of around USD 1.8 trillion per year (IEA, 2019c), and USD 2.9 trillion per year in the Planned Energy Scenario.

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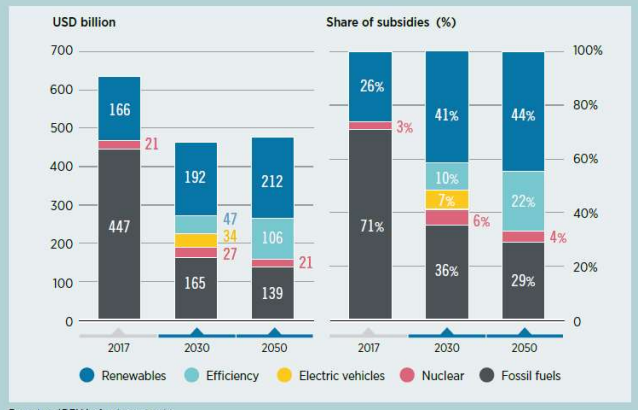
Energy Subsidies in the Energy Transformation

Figure 1.3 Energy subsidies: Overall reduction in the Transforming Energy Scenario
Total direct energy sector subsidies by fuel/source, 2017, 2030 and 2050 in the Transforming Energy Scenario

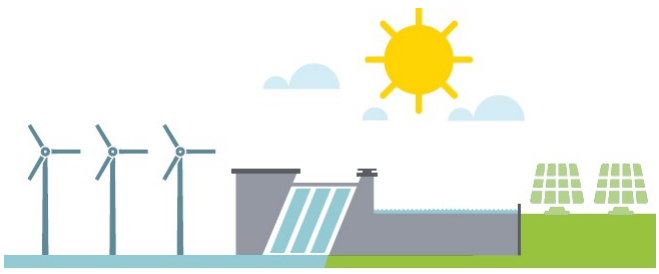


Based on IRENA (forthcoming b)

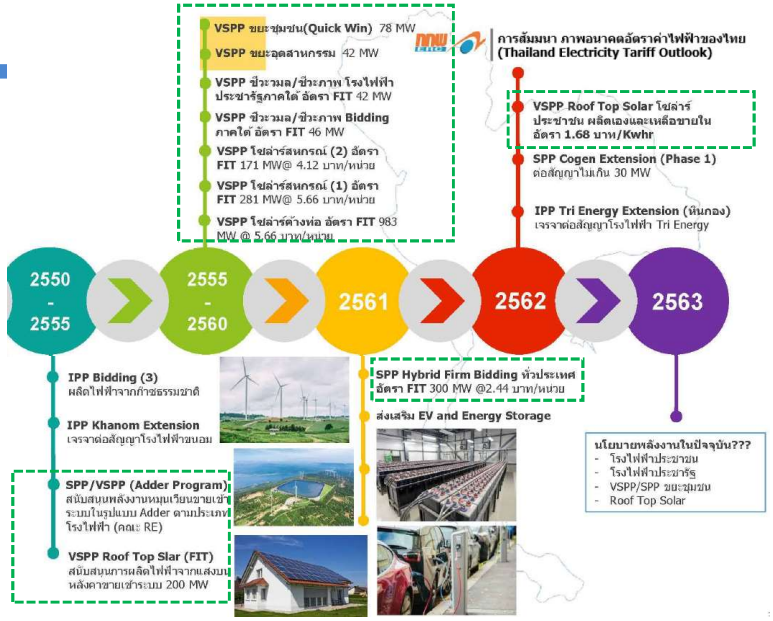
Subsidies:
- Reduce subsidies on fossil fuels
- Increase subsidies on RE

5. Renewable Energy Development in Thailand

- Policy support to investment in renewable energy
  - Current and plan for renewable energy
- Key supporting policies driven RE development
  - Average electricity rate
  - Cost of renewable energy in Thailand



Policy supports to private electricity producers



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Alternative Energy Development Plan (AEDP2018)

แผนพัฒนาพลังงานทดแทนและพลังงานทางเลือก พ.ศ. 2561-2580 (AEDP2018)

แผนพัฒนาพลังงานทดแทน พลังงานทดแทนเพื่อผลิตไฟฟ้า	แผน AEDP2015 เป้าหมาย*	แผน AEDP2015 ดำเนินการแล้ว	แผน AEDP2018 แผนพัฒนาตาม PDP2018	แผน AEDP2018 รวมเป้าหมาย	ผลต่าง 2018-2015
พลังงานแสงอาทิตย์ (MW)	6,000	2,849	12,725	15,574	9,574
ชีวมวล (MW)	5,570	2,290	3,496	5,786	216
พลังงานลม (MW)	3,002	1,504	1,485	2,989	- 13
ก๊าซชีวภาพ (น้ำเสีย/ของเสีย) (MW)	600	382	546	928	328
ขยะชุมชน (MW)	500	500	400	900	400
ขยะอุตสาหกรรม (MW)	50	31	44	75	25
พลังน้ำขนาดเล็ก (MW)	376	188	-	188	- 188
พลังน้ำขนาดใหญ่ (กฟผ.) (MW)	2,906	2,918	-	2,918	12
ก๊าซชีวภาพ (พืชพลังงาน) (MW)	680	-	-	-	- 680
รวม (MW)	19,684	10,662	18,696	29,358	9,674
ผลิตไฟฟ้าจากพลังงานทดแทน : AE (%)	20%	10%	20%	33%	13%

หมายเหตุ

*(1) *เฉพาะเป้าหมายตามแผน AEDP2015 เป็นตัวเลขกำลังผลิตติดตั้ง (Installation capacity) นอกเหนือจากนั้นเป็นกำลังผลิตตามสัญญา (Contract capacity)*

(2) ไม่รวมการพัฒนาพลังงานทดแทนเพื่อผลิตไฟฟ้า เช่น พลังน้ำ ความร้อนใต้พิภพ ไฮโดรเจน เชลล์เชื้อเพลิง และอื่น ๆ ที่ไม่มีในแผนพัฒนาตาม PDP2018 เป็นเป้าหมายเพิ่มเติมภายใต้แผน AEDP2018 ด้วย

Source: FTI (2020) เอกสารสัมมนา AEDP ภาคประชาชน

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Solar and wind subsidies in Thailand

Timeline: Solar Subsidies in Thailand

2550	ภาครัฐเปิดให้ภาคเอกชนลงทุนในโครงการ VSPP โดยสนับสนุนในรูปแบบ Adder ที่ 8.00 บาท/ kWh	ADDER 8.00 บาท
		↓ 19%
2553	ปรับ Adder ลงอยู่ที่ 6.50 บาท / kWh	ADDER 6.50 บาท
2556	เปลี่ยนจาก Adder เป็น Feed-in Tariff หรือ FiT สำหรับ Solar Rooftop โดย:	ADDER
	- บ้านอยู่อาศัย ≤ 10 kWp 6.96 บาท/หน่วย	↓
	- ธุรกิจ/รง. > 10-250 kWp 6.55 บาท/หน่วย	FiT 6.16-6.96 บาท
	- ธุรกิจ/รง. > 250-1,000 kWp 6.16 บาท/หน่วย	↓ 12%-18%
2557	ปรับ FIT Solar แบบติดตั้งบนพื้นดิน และ Solar Rooftop	FiT 5.66-6.85 บาท
	- บนพื้นดิน 5.66 บาท/หน่วย	↓ 27-40%
	- บ้านอยู่อาศัย ≤ 10 kW 6.85 บาท/หน่วย	FiT 4.12 บาท
	โดยในพื้นที่ชายแดนภาคใต้ได้ FIT พิเศษเพิ่ม 0.50 บาท/หน่วย	↓ 60%
2560	ภาครัฐได้ปรับ FIT ลงอยู่ที่ 4.12 บาท / kWh	FiT 1.68 บาท
2562	กฟภ. เปิดรับสมัครประชาชนผู้สนใจเข้าร่วมโครงการโซลาร์ภาคประชาชน โดย:	
	- บ้านอยู่อาศัย ≤ 10 kW 1.68 บาท/หน่วย	
	ระยะเวลา 10 ปี	

Timeline: Wind Subsidies in Thailand

2550	ภาครัฐเปิดให้ภาคเอกชนลงทุนในโครงการ VSPP โดยสนับสนุนในรูปแบบ Adder ที่ 2.50 บาท/kWh	ADDER 2.50 บาท
		↓
2553	ปรับ Adder เพิ่มเป็น 3.5 บาท/kWh	ADDER 3.50 บาท
2557	เมื่อวันที่ 22 ตุลาคม 2557 กพช. ได้อนุมัติหลักการในการปรับเปลี่ยนมาตรการส่งเสริมการผลิตไฟฟ้าจากพลังงานหมุนเวียนในระบบ Adder เป็นระบบ Feed-in Tariff (FiT) โดยกระทรวงพลังงานได้จัดทำอัตรารับซื้อไฟฟ้าในรูปแบบ FiT ในราคา 6.06 บาท/kWh	↓
		FiT 6.06 บาท

Auctions to procure electricity in Thailand

1st Auction

Target	FiT (Ceiling price) Year 1-8	Year 9-20
Biogas 10 MW (liquid/solid waste)	14.42	12.91
Biomass 36 MW	15.27	14.36

US cents /kWh

Biogas (liquid/solid waste) — 5.95 MW awarded

Rank	MW	% discount	Year 1 - 8	Year 9 -20
1	3.00	23.33	11.76	10.24
2	2.00	10.25	13.24	11.73
3	0.95	10.05	13.27	11.76

Biomass — 36 MW awarded

Rank	MW	% discount	Year 1 - 8	Year 9 -20
1	9.90	81.17	9.39	8.48
2	9.90	81.17	9.39	8.48
3	9.90	77.19	9.70	8.79
4	6.30	67.78	10.36	9.45

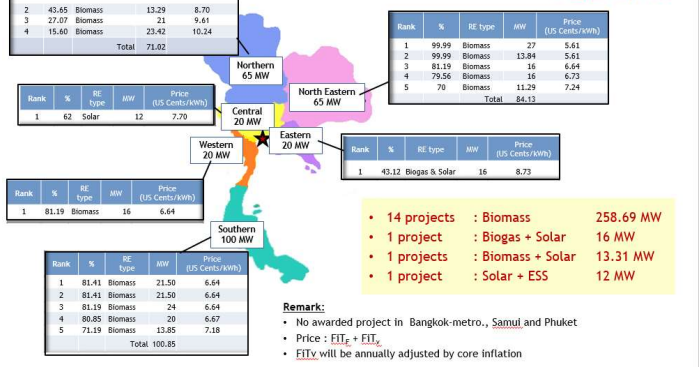
Awarded SPP Hybrid-Firm Projects

FX: 33 THB/USD

Ceiling price: 11.09 UD Cents /kWh → Bidding

Proposals received	85	1,644.25 MW	
Technical qualified	42	755 MW	8.58 US Cents/kWh
Awarded	17	300 MW	7.39 US Cents/kWh

Avg. bid price



- 14 projects : Biomass 258.69 MW
- 1 project : Biogas + Solar 16 MW
- 1 projects : Biomass + Solar 13.31 MW
- 1 project : Solar + ESS 12 MW

Remark:
- No awarded project in Bangkok-metro., Samui and Phuket
- Price : $FIT_F + FIT_V$
- FIT_V will be annually adjusted by core inflation

FIT for community-based power plant project:

อัตรารับซื้อไฟฟ้าในรูปแบบ Feed-in Tariff สำหรับโครงการโรงไฟฟ้าชุมชนเพื่อเศรษฐกิจฐานราก ที่ผ่านความเห็นชอบจาก กพช. แล้ว เมื่อวันที่ 16 ธันวาคม 2562

กำลังผลิต (MW)	FiT (บาท/หน่วย)			ระยะเวลาสนับสนุน	FiT Premium (บาท/หน่วย)
	FiT_F	FiT_{V2562}	FiT[1]		พื้นที่พิเศษ[2]
1) พลังงานแสงอาทิตย์					
กำลังผลิตติดตั้งทุกขนาด	2.90	-	2.90	20 ปี	0.50
2) ชีวมวล					
กำลังผลิตติดตั้ง ≤ 3 MW	2.61	2.2382	4.8482	20 ปี	0.50
กำลังผลิตติดตั้ง > 3 MW	2.39	1.8736	4.2636	20 ปี	0.50
3) ก๊าซชีวภาพ (น้ำเสีย/ของเสีย)					
กำลังผลิตติดตั้งทุกขนาด	3.76	-	3.76	20 ปี	0.50
4) ก๊าซชีวภาพ (พืชพลังงาน)					
กำลังผลิตติดตั้งทุกขนาด					
- กรณีพืชพลังงาน 100%	2.79	2.5825	5.3725	20 ปี	0.50
- กรณีผสมน้ำเสีย/ของเสีย ≤ 25%	2.79	1.9369	4.7269	20 ปี	0.50

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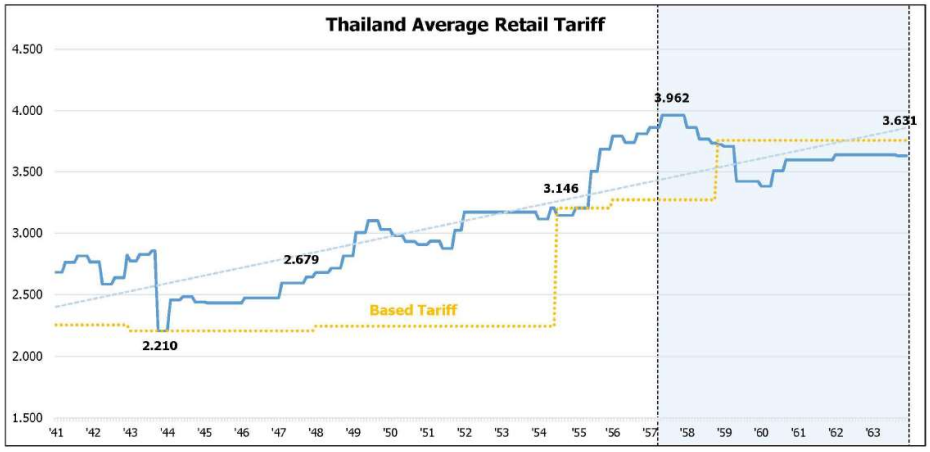
Thailand Electricity Tariffs



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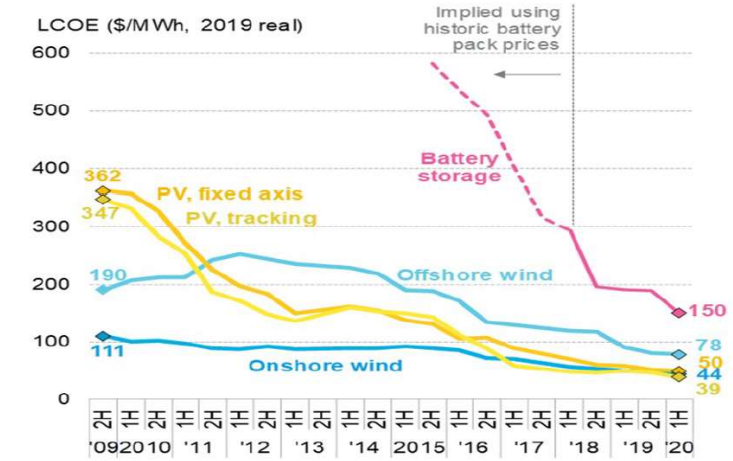
Costs of renewable technologies (LCOE)



LCOE Benchmarks	In THB / W
Battery Storage	4.650
Offshore Wind	2.418
Onshore Wind	1.364
PV (Fixed)	1.550
PV (Tracking)	1.209

Source: Bloomberg NEF

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Cost of solar rooftop investment for self-consumption in Thailand

1. บ้านพักอาศัย (10kW)

ลงทุนทั้งสิ้น (CAPEX+OPEX)	837,500 บาท
ไฟฟ้าที่ผลิตได้ภายใน 25 ปี	324,270 kWh
LCOE*	2.58 บาท/kWh

2. กิจการขนาดเล็ก (30kW)

ลงทุนทั้งสิ้น (CAPEX+OPEX)	2,268,750 บาท
ไฟฟ้าที่ผลิตได้ภายใน 25 ปี	972,210 kWh
LCOE*	2.33 บาท/kWh

3. กิจการขนาดกลาง (300kW)

ลงทุนทั้งสิ้น (CAPEX+OPEX)	20,268,750 บาท
ไฟฟ้าที่ผลิตได้ภายใน 25 ปี	9,722,105 kWh
LCOE*	2.08 บาท/kWh

4. กิจการขนาดใหญ่ (1000kW)

ลงทุนทั้งสิ้น (CAPEX+OPEX)	57,517,250 บาท
ไฟฟ้าที่ผลิตได้ภายใน 25 ปี	32,407,015 kWh
LCOE*	1.77 บาท/kWh

*ในกรณีที่ผลิตใช้เอง 100%

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Link to useful resources

- ตัวอย่างเครื่องมือสนับสนุนทางการเงินของกรมอนุรักษ์พลังงานและพลังงานทดแทน
- นโยบายและบทบาทภาครัฐในการสนับสนุนพลังงานทดแทน
- PDP 2018 Rev. 1
- เอกสารงานสัมมนา AEDP ภาคประชาชน
- IRENA's Global Renewables Outlook: Energy Transformation 2050
- Renewables Global Status Report (REN 21)

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Toward Just Energy Transition:

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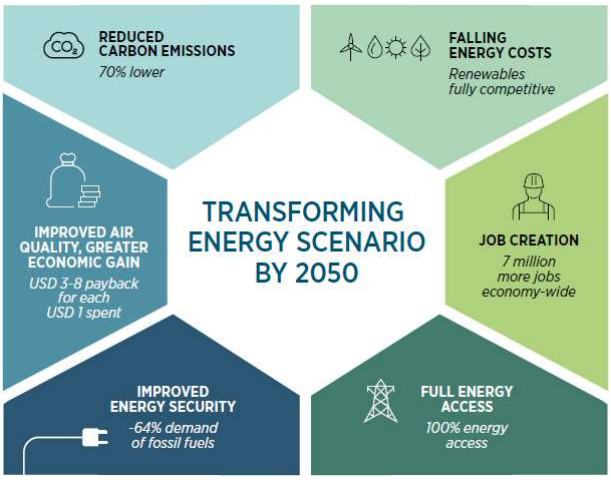
Key Drivers for Energy Transition



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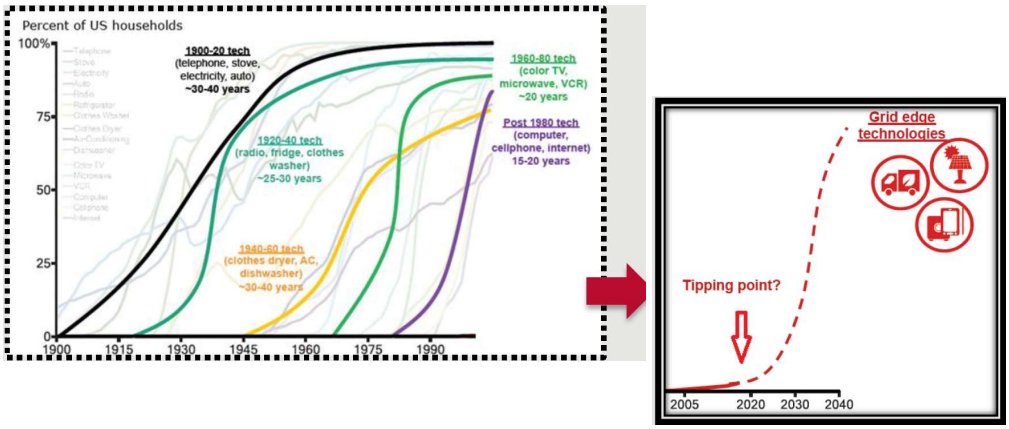
Timing for Electricity Sector Transformation



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Source: World Economic Forum (2017)

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Thailand's Energy Transformation (4D+IE)

- DECARBONIZATION
- DIGITALIZATION
- DECENTRALIZATION
- DE-REGULATION
- ELECTRIFICATION

01 Decarbonization (CO2)
การลดปริมาณคาร์บอน

02 Decentralization
การผลิตไฟฟ้าแบบกระจายตัว เป็นที่นิยมมากขึ้น เนื่องจากเทคโนโลยีการกำเนิด กระแสไฟฟ้าขนาดเล็กมีต้นทุนที่ต่ำลง

03 Deregulation
การผ่อนคลายกฎระเบียบ เพื่อส่งเสริมการการใช้พลังงานหมุนเวียน (Renewable Energy) จากมาตรการ Feed-in tariffs (FiTs) และ Net-metering ไปสู่การแข่งขันเสรี

04 Electrification
การใช้พลังงานในรูปแบบของพลังงานไฟฟ้าเพิ่มขึ้น

05 Digitalization
การก้าวเข้าสู่ยุคดิจิทัล เทคโนโลยีอินเทอร์เน็ตของสรรพสิ่ง (IoT) และ Blockchain ทำให้อุตสาหกรรมไฟฟ้าในอนาคตเปลี่ยนแปลงไป

ปัจจัยที่ส่งผลต่อการกำหนดทิศทางการพัฒนาภาคไฟฟ้าของประเทศ

- RE มีต้นทุนการผลิตลดลง
- เศรษฐกิจยุคไฟฟ้า
- กระแสด้านสิ่งแวดล้อม
- การก้าวสู่ยุคดิจิทัล
- ความร่วมมือระหว่างประเทศ

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ตัวอย่างมุมมองจาก กฟผ. เกี่ยวกับ Energy Transformation (3D+1E)

1 Decarbonization
พันธสัญญาตามข้อตกลง COP21 จำกัดการเพิ่มขึ้น ของอุณหภูมิเฉลี่ยของโลกไม่เกิน 2°C

"the world abandon fossil fuels"

Almost Half Coal Power Plants Seen Unprofitable to Operate

Japan says no to high-emission coal power plants

Germany agrees to end reliance on coal stations by 2038

Netherlands to ban coal-fired power plants in blow to RWE

Fossil Based

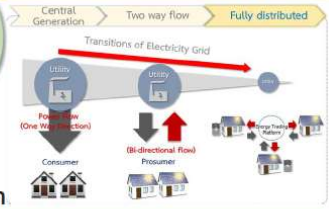
First Generation

Moving forward
"ทำอย่างไรให้การเปลี่ยนผ่านเป็นไปอย่างราบรื่น"

RE Based

Second Generation

2 Decentralization
การผลิตพลังงานแบบกระจายตัว ในรูปแบบสองทิศทาง (two way flow)



ทั้ง 3Ds เชื่อมโยงกับ Electrification
การใช้พลังงานที่จะใช้ไฟฟ้ามากขึ้นจาก
คมนาคมขนส่ง ➡ ยานยนต์ไฟฟ้า
บ้านอยู่อาศัย & อุตสาหกรรม ➡ ระบบทำความร้อน

3 Digitization
การเปลี่ยนแปลงในยุคดิจิตอล เทคโนโลยีขั้นสูง ได้แก่ Internet Of Things, Big Data Analytics, Artificial Intelligence และ Blockchain นำไปสู่ **โรงไฟฟ้าเสมือน**

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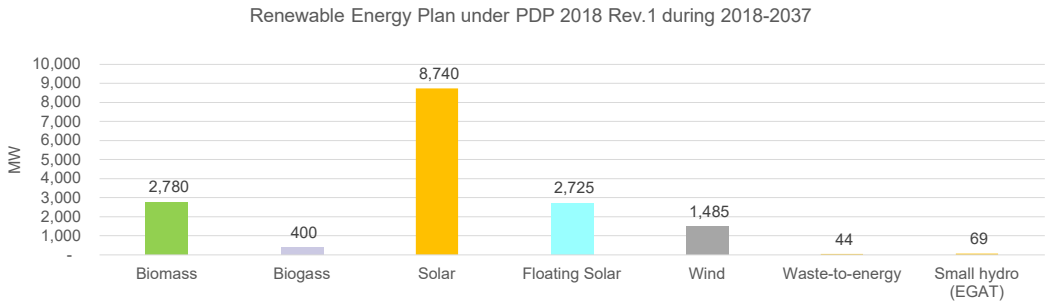
Thailand's transition towards more renewables: New RE during 2018-2037 under PDP 2018 Rev.1



Unit: MW	Year 2037
Biomass	4,694
Biogass	1,565
Solar	12,029
Floating Solar	2,725
Wind	2,989
Waste-to-energy	828

MOE is planning for an integrated plan (expected in 2022) for increasing renewables in the power sector, including coal phase-out plan.

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PDP 2018 Rev.1 (Effective in October 2020)

แผนช่วงแรกดำเนินการ ในปี 2563-2570

ปี	2563	2564	2565	2566	2567	2568	2569	2570
กฟผ.	รฟ. บางประกง ทดแทน 1-2 1,386 MW Floating Solar/พลังน้ำ 47.5 MW	พลังน้ำ 14 MW	Floating Solar/พลังน้ำ 47.5 MW		รฟ.น้ำพอง ทดแทน 700 MW พลังน้ำขนาดเล็ก 6 MW	รฟ. พระนครใต้ (ส่วนเพิ่ม) 700 MW รฟ. แม่มาะ ทดแทน 8-9 600 MW Floating Solar/พลังน้ำขนาดเล็ก 302.3 MW	รฟ. พระนครใต้ (ส่วนเพิ่ม) 1,400 MW รฟ. สุราษฎร์ธานี ชุดที่ 1 700 MW Floating Solar/พลังน้ำขนาดเล็ก 53.5 MW
IPP		กัลฟ์ เอสเอกซ์ ชุดที่ 1 1,250 MW	กัลฟ์ เอสเอกซ์ ชุดที่ 2 1,250 MW	กัลฟ์ พีดี ชุดที่ 1 1,250 MW	กัลฟ์ พีดี ชุดที่ 2 1,250 MW หินกอง เพาเวอร์ ชุดที่ 1 700 MW	หินกอง เพาเวอร์ ชุดที่ 2 700 MW	บูรพา พาวเวอร์ 540 MW	
VSPP	56 MW	17 MW						
SPP	135 MW	584.4 MW	60 MW	30 MW	240 MW	60 MW		
ซื้อไฟต่างประเทศ			น้ำเทิน1 514 MW				700 MW	
รฟ.ชุมชน	700 MW	350 MW	323 MW	280 MW	280 MW			
Solar ประชาชน/อื่นๆ	47 MW	50 MW	50 MW	50 MW	50 MW			เปิดรับซื้อใหม่
รฟ.ขยะชุมชน			400 MW					
ชีวมวล ประชารัฐ			60 MW	60 MW				
พลังงานลม			90 MW	90 MW	90 MW			

รับซื้อไฟฟ้า RE มีสัญญาผูกพันเดิม 1,179 MW

เปิดรับซื้อไฟฟ้า RE ใหม่ 2,973 MW

- รฟ.ชุมชน 1,933 MW
  ปี 63 : 700 MW (Quick win 100 MW+600 MW)
- รฟ.ขยะชุมชน 400 MW
- รฟ.ชีวมวลประชารัฐ 120 MW
- รฟ.พลังงานลม 270 MW
- รฟ.พลังงานแสงอาทิตย์ & Solar ภาคประชาชน 250 MW

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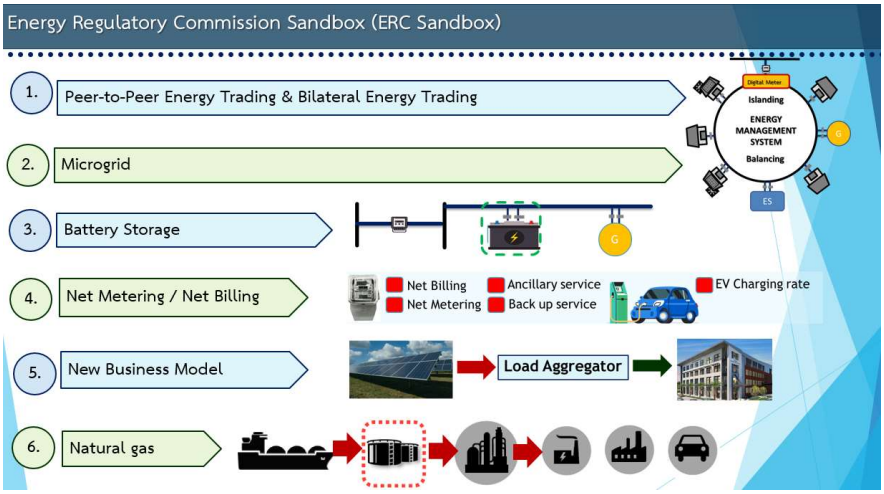
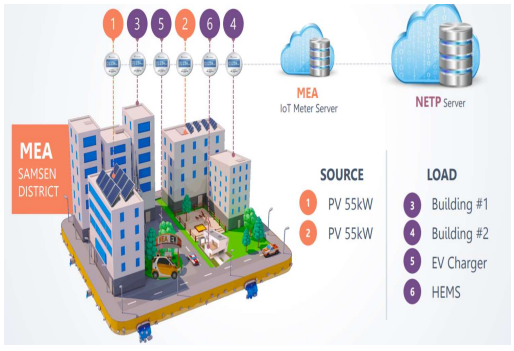
Supporting Regulations: ERC sandbox projects



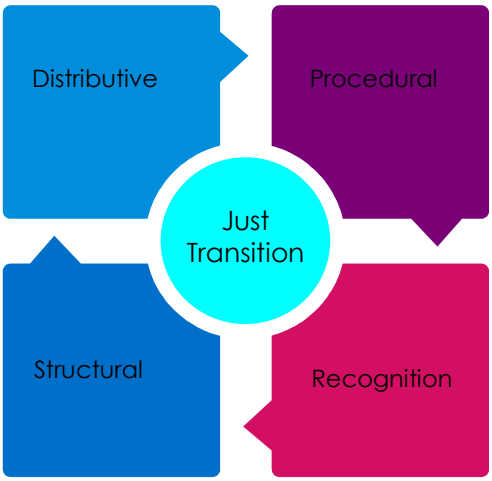
Examples of peer-to-peer pilot projects



Principles of "Just Transition"

COMMITMENT TO THE PRINCIPLES OF A JUST TRANSITION: Making sure no one is left behide

Justice is conceived in terms of the **distribution or sharing out of good** (resources) and **bads** (harms and risks)



Justice is conceived in terms of **the way decisions are made**, who is involved and has influence, and access to the formal justice system

Justice is conceived of a **responsibility to work collectively** to **transform institutional structures** that produce or perpetuate injustice

Justice is conceived in terms of **who is given respect and who is and isn't valued**

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Consideration for a Just Transition

Measures to ensure a **JUST ENERGY TRANSITION**:

- Provide the population with **sufficient energy resources** of high quality, without burdening financially the customers
- As part of the **regulatory reform, vulnerable customers will be protected** via measures to provide them relief
- Respect **due process and human rights** in our production and use of energy
- Consumers and Communities will be part of the transition by **inclusion in public consultations** before implementation of reforms**, increasing public awareness** and **education** on electrification and actions taken to reduce emissions, publication of periodic progress reports

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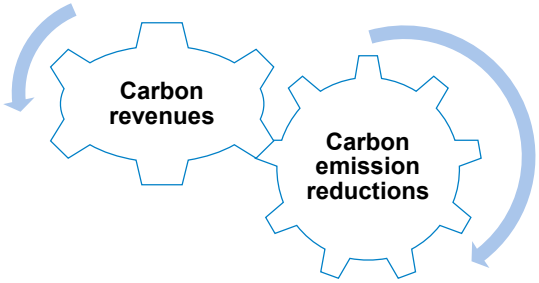
Example: Carbon tax case

Context of carbon tax imposition

Carbon tax imposed on fossil fuels consumption in **two most emission intensive industries**, **Energy** and **Transport**. This will have effects across the economy, incentivizing emission reductions across all sectors.

Carbon Tax will also generate revenues
For 'Just Transition' and other policies.



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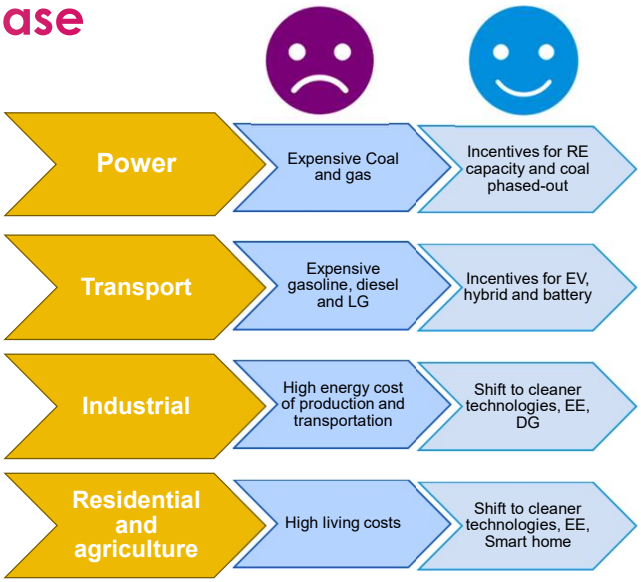
Example: Carbon tax case

IMPACTS OF CARBON TAX

Barriers or perceived negative impact

- Economic growth
- Employment
- Industrial growth
- Welfare



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Example: Carbon tax case

IMPACTS OF CARBON TAX: MODELLING & ANALYSIS

Economic and employment impact

- Economic growth (%)
- Employment
- Industrial growth

Social impact

- Household welfare
- Income inequality
- Poverty reduction

DOCUMENT;
Carbon tax impact Report

CO2 emissions reduction by sector

- Elasticity of demand to price changes

Carbon tax revenue allocation

- RE
- EE
- Compensation (household, agriculture)
- Building and infrastructure

***Monitoring indicators for policy evaluation every two years

Case Study: A just transition from Coal to Renwables

A roadmap for a just transition from Coal to Renewables

Learn from a Case Study: Insights from national coal-phase out discussions in Germany

- The role of coal in Germany's energy system, economy and environment.
- Coal-phase out plan (timeline and step by step)
- Critique and discussion to phase out coal
- Comparing the socio-political and techno-economic environment of the coal regimes in Germany and the UK pathways
- Discussion on the context of coal-phase out in Thailand

Photo Credit: Clean Energy Wire website

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Case studies: The UK and Germany

Why choose UK and Germany to study about coal phase-out pathway?

- Coal plays a major role for both countries
- UK: Decided in 2015 to phase out coal by 2025, replaced coal with natural gas and large-scale RE
- Germany: Considered to phase out coal by 2038, replaced coal with renewables

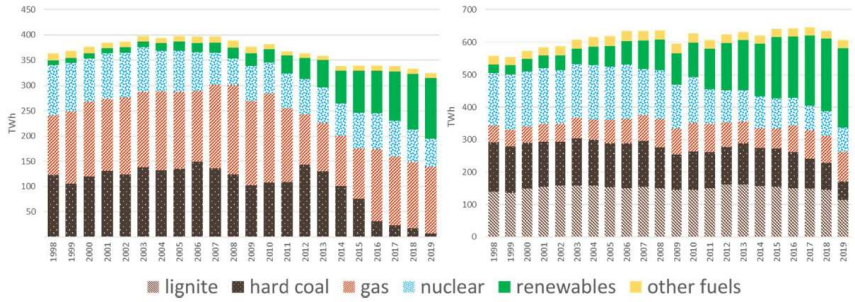

Fig. 2. Gross Electricity Generation for the UK (left) and Germany (right) in TWh.
Own depiction based on the Department for Business, Energy & Industrial Strategy (2020), Umweltbundesamt (2020a), AG Energiebilanzen (2020); numbers for 2019 are preliminary.

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Stories behind diverging transition

UK

- **International competition on coal business** led to a quick decline of coal
- **Political incentive**: Starting in 2006, climate friendly political decisions creates opportunities for those prioritizing environment (high awareness of climate change.
- **Focus on cost efficiency** and not supporting new entrants (preference for large-scale technologies)
- **Several policies constrained coal's business** such as the Carbon Price Floor (CPF), the Renewable Obligations (RO), the Emissions Performance Standard (EPS) and the Climate Change Act (2008)
- **Incentivized incumbent** to deploy RE themselves
- **Subsidies for renewables were cut heavily in 2015** result in barriers for small scale RE projects, slow down RE investment and increase the need to use NG as replacement of coal

"Incumbent-led" energy transition in the UK

Germany

- **Long subsidized coal by the Government**– existing incumbents the power to influence policies to support coal and a gradual phase-out plan
- **A Phase-out nuclear law in 2011 by 2022** make a coal-phase out more difficult as both comprise of 64% share of electricity generation
- **EU regulation forbid coal subsidies in 2018**, so hard coal mining declined and ended in Dec 2018.
- **Market pressures on coal business,** increasing the prices for allowance of EU Emission Trading System in 2019, shrinking gas prices made coal combustion increasingly uneconomic.
- **Renewable Energy Sources Act (EEG) in 2004** provided attractive FTI for green and support new market participants in RE. The Green Growth discourse further pushed the transition

"New-entrant-led disruptive" energy transition in Germany

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Source: Brauers et al. (2020). Comparing coal phase-out pathways: The UK and Germany's diverging transition

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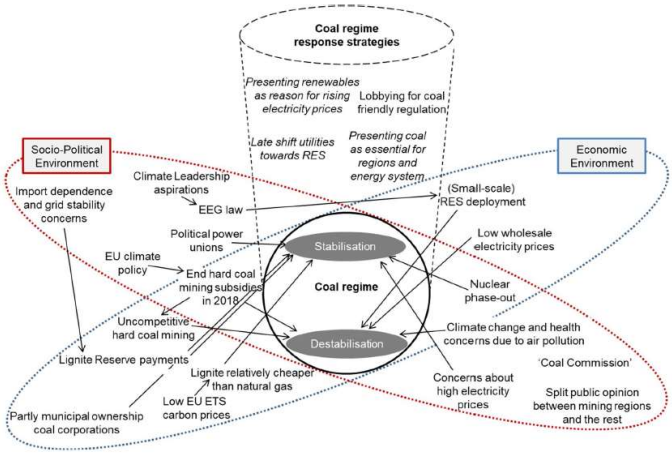
Incumbent coal firms' responses

In Germany

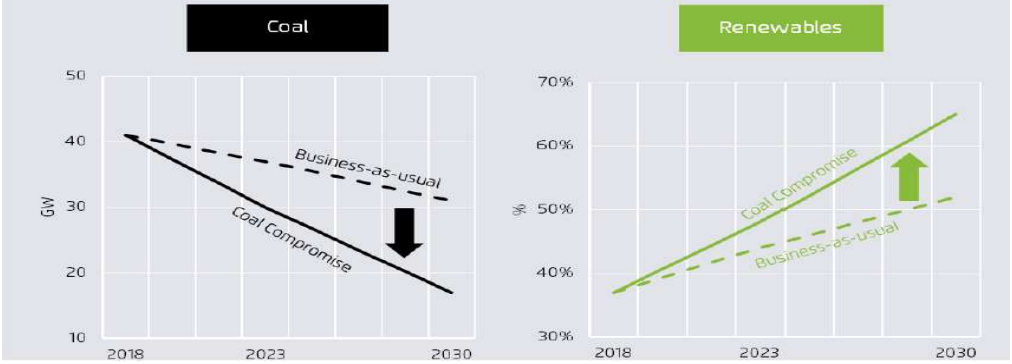
- Lobby for coal friendly regulation
- Misrepresent the effect of renewables for the general public
  - On electricity price– FIT for renewables paid by consumers explicitly on bills while coal subsidized by state budget not visible to consumers.
  - Uncompetitive German industries with increasing energy costs
  - Energy security despite that various studies showing that grid stability is not threatened by increasing RE
- Make German industries uncompetitive by increasing energy costs
- Underestimate the fast growth of RE, so missed the opportunity to invest in non-fossil fuel technologies and unwilling to invest in small-scale RE projects.



Source: Brauers et al. (2020). Comparing coal phase-out pathways: The UK and Germany's diverging transition

Coal phase-out plan to renewables in Germany

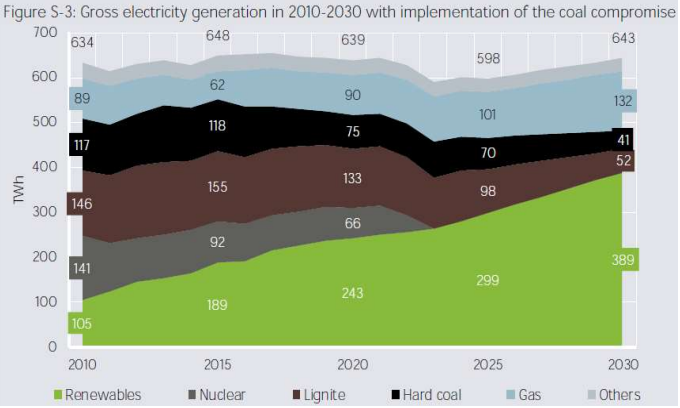
Figure 18: Coal-fired power plant capacity and the share of renewable energy in gross electricity consumption in 2018, 2023, and 2030



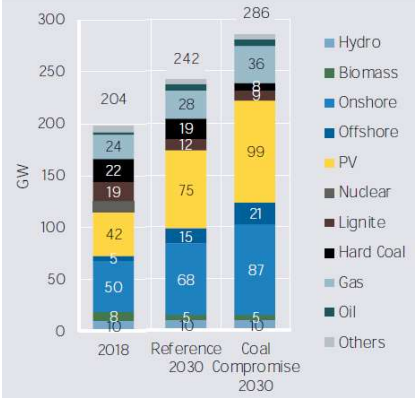
Source: Agora (2019). A roadmap for a just transition from coal to renewables

Coal phase-out plan to renewables in Germany

Figure S-3: Gross electricity generation in 2010-2030 with implementation of the coal compromise



Generation capacities (net) in 2018, 2023, and 2030



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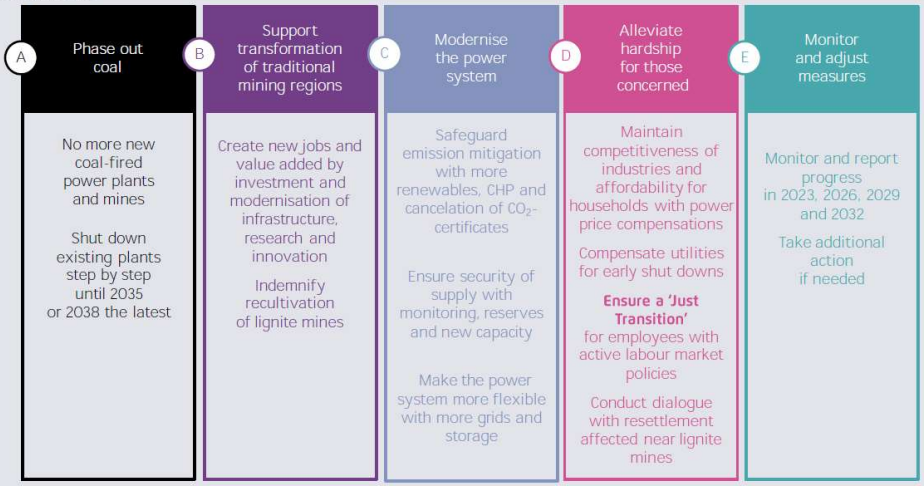
Source: Agora (2019). A roadmap for a just transition from coal to renewables

Step by Step to phase out coal

Figure 11: Overview of the recommendations of the Commission on Growth, Structural Change, and Employment



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Source: Agora (2019). A roadmap for a just transition from coal to renewables

Step by Step to phase out coal: A

Phase out coal step by step

No more new coal-fired power plants and mines

- No permitting for new coal plants and preferably no connecting to the grid of power plants still being built
- No permitting of new mines for energetic use and preferably preservation of Hambach forest near Hambach mine

Shut down existing coal-fired power plants step by step

- Gradual reduction of existing coal-fired power plant capacities in the market:
  - to a maximum of 15 GW of lignite and 15 GW of hard coal in 2022
  - to a maximum of 9 GW of lignite and 8 GW of hard coal in 2030
  - phase out by 2038 at the latest; In 2032 it will be examined whether a complete phase-out of coal is already possible by 2035

In order to ensure sufficient legal certainty, the Commission recommends that, as an instrument, consensual negotiation agreements, including compensation payments, should be concluded with operators by 2022. These are then to be fixed by law. For the period from 2023 to 2030, the Commission recommends a competitive bidding process to determine which hard-coal-fired power stations will be decommissioned and the level of compensation to be received. By contrast, the phase-out for lignite-fired power plants will continue to be based on negotiated solutions. If no amicable agreement can be reached between the federal government and the operators by 30 June 2020, the federal government should adopt a mandatory decommissioning schedule, including appropriate compensation for power plant operators.

Source: Agora (2019). A roadmap for a just transition from coal to renewables

Step by Step to phase out coal: B

B Support the transformation of traditional mining regions

Creating new employment and value added

- Modernisation of energy infrastructure in including the expansion of renewables, grids, storage and PtX
- Speeding up formal planning processes
- Developing ‚model regions'
- Investment in transport and digital infrastructure as well as R&D
- Locating federal government offices and employees

Indemnify recultivation of opencast lignite mines

- Adaption of permits to changes in lignite demand
- Usage of the possibility of security payments when approving permit changes
- Usage of compensation payments for power plant operators for recultivation

Source: Agora (2019). A roadmap for a just transition from coal to renewables

Step by Step to phase out coal: C

C — Modernise the power system

Safeguard emission mitigation of phase out

- Expansions of renewables to 65% of gross electricity consumption by 2030
- Cancelation of CO_2 certificates
- Examination of appropriate CO_2 pricing in sectors outside emissions trading

Ensure security of supply

- Expansion of measures to monitor security of supply
- Usage of existing reserve mechanism and replacement of decommissioned coal capacities from the reserve
- Continuation and modernisation of CHP support
- Examination of capacity mechanism in 2023 if needed

Make the power system more flexible

- Modernisation and better use of grids through optimisation, expansion and market measures
- Promotion of storage systems
- Review of the existing tax and levy system in the energy sector

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Source: Agora (2019). A roadmap for a just transition from coal to renewables

Step by Step to phase out coal: D

D — Alleviate hardship for those concerned

Ensure socially acceptable implementation

- Protections against dismissal, enabling early retirement without financial losses, provisions for retraining, and measures for reallocation to new jobs for coal workers
- Power price compensation for households
- Engagement in dialog of regional governments with residents near mines

Maintain competitiveness of commercial and industry

- Continue and further develop CO_2 electricity price compensation at the European level
- Power price compensation for commercial and industry

Phase out in agreement with power plant operators

- Financial compensation for power plant operators for the early shut-down of capacities in a negotiative and/or competitive bidding process

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Source: Agora (2019). A roadmap for a just transition from coal to renewables

Step by Step to phase out coal: E

E Monitor and adjust measures

Regularly review the measures and report progress

- Close monitoring in accordance with specific criteria and recorded in progress reports in the years 2023, 2026, and 2029
- Establishment of an independent panel of experts to assess progress
- Presentation in and resolution of the reports in and by the federal cabinet and the Parliament

Take additional action if needed

- Consistent adjustment if the implementation of the measures has shortcomings

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Source: Agora (2019). A roadmap for a just transition from coal to renewables

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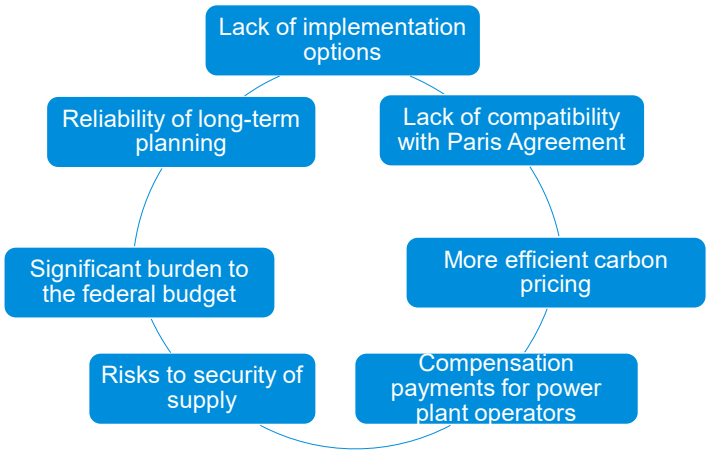
Critique and discussions



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