ASEAN's Energy Future: Challenges and Opportunities in the New Energy World" with special focus on Thailand

STIPI, Bangkok

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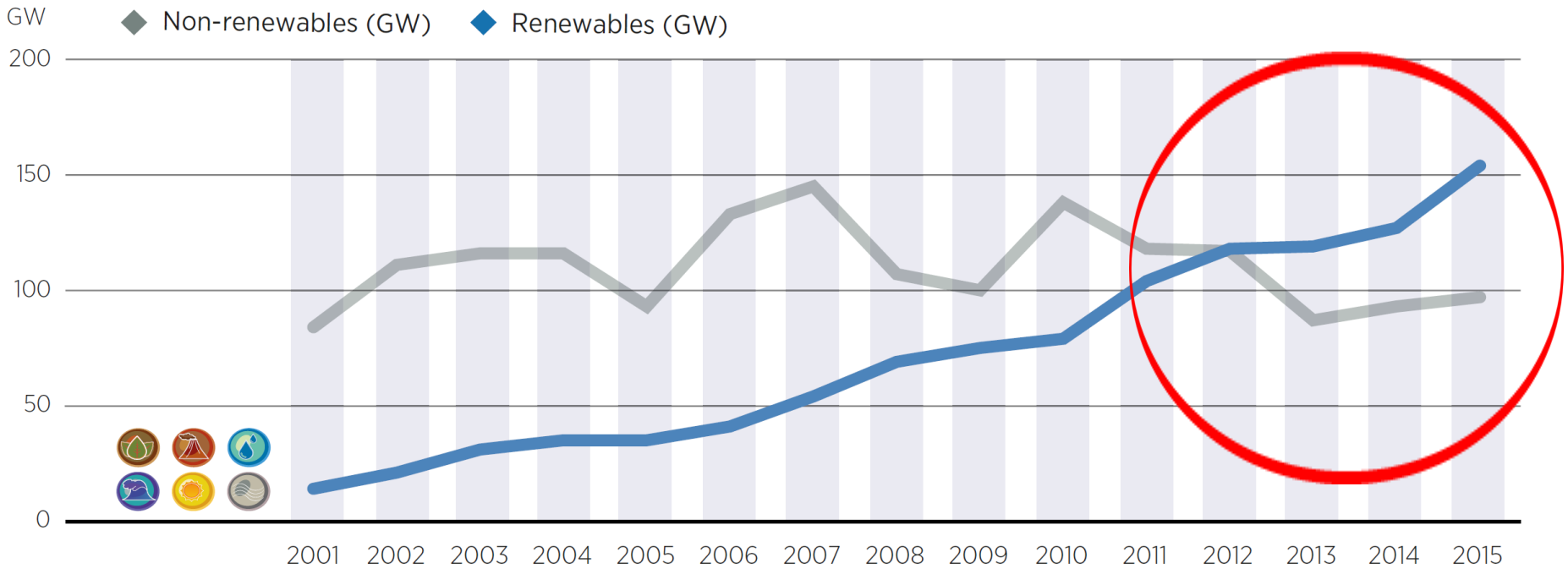
Worldwide renewable and non-renewable power capacity additions
The global trend is towards much more PV and wind…



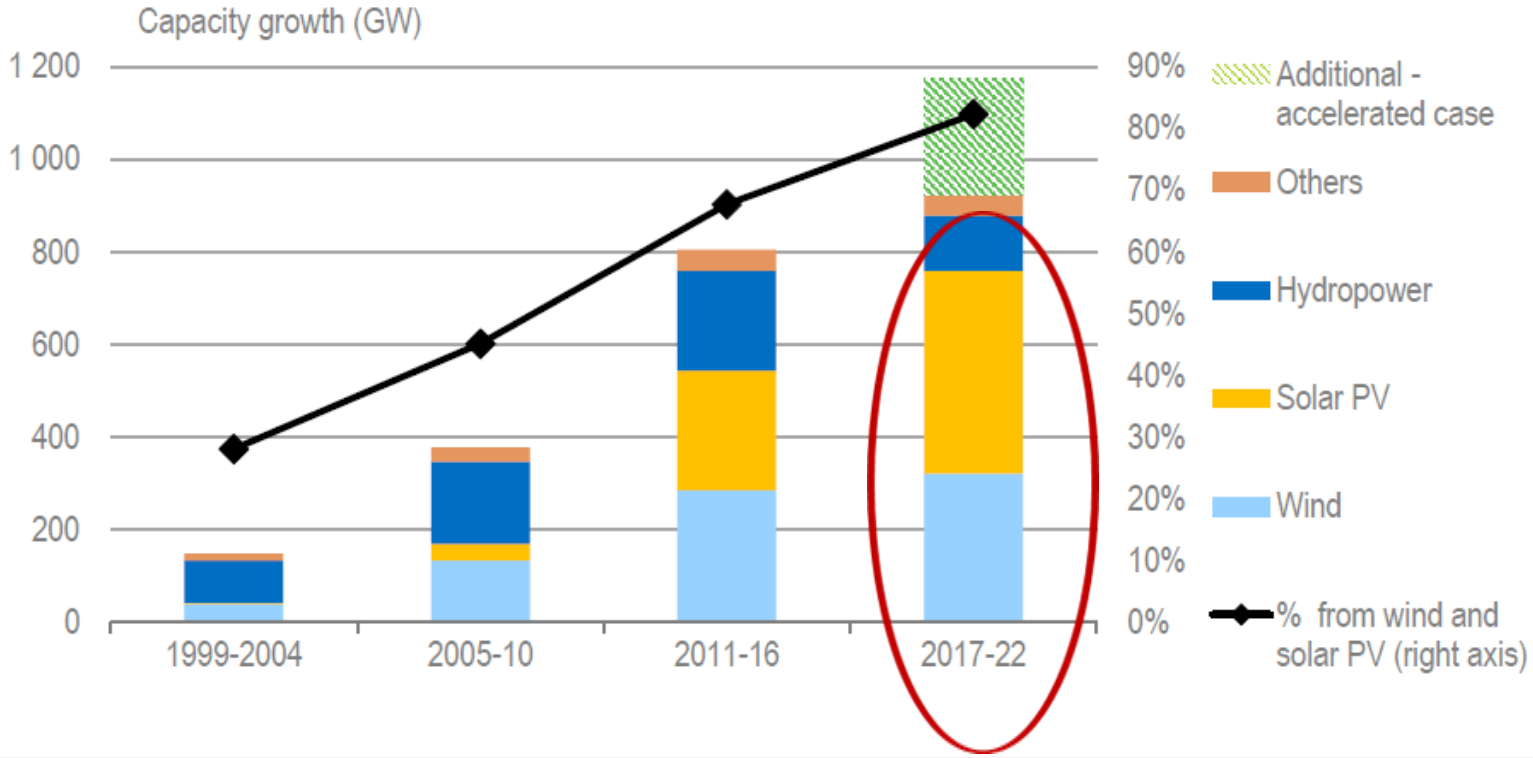
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Renewables (GW)	14	21	31	35	35	41	54	69	75	79	104	118	119	127	154
Non-renewables (GW)	84	111	116	116	93	133	145	107	100	138	118	117	87	93	97

Source: IRENA, 2016b

Source: IRENA (2017), REthinking Energy 2017: Accelerating the global energy transformation. International Renewable Energy Agency, Abu Dhabi.

Renewables growth more and more dependent on wind and solar

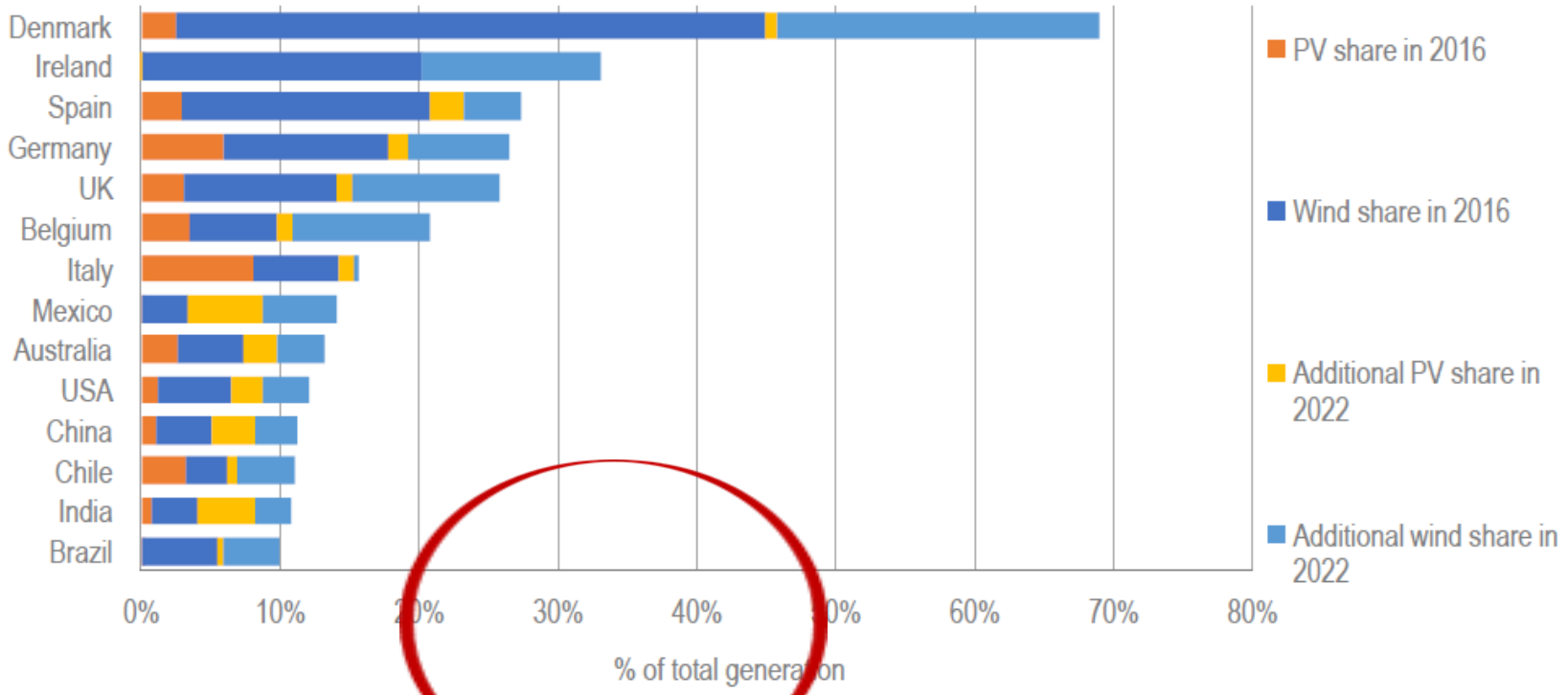
Renewable electricity capacity growth by technology



Solar PV enters a new era, becoming the undisputed leader in renewable power capacity growth; PV also accounts for 60% of the upside potential in the accelerated case

Wind & solar leading power sector transformation

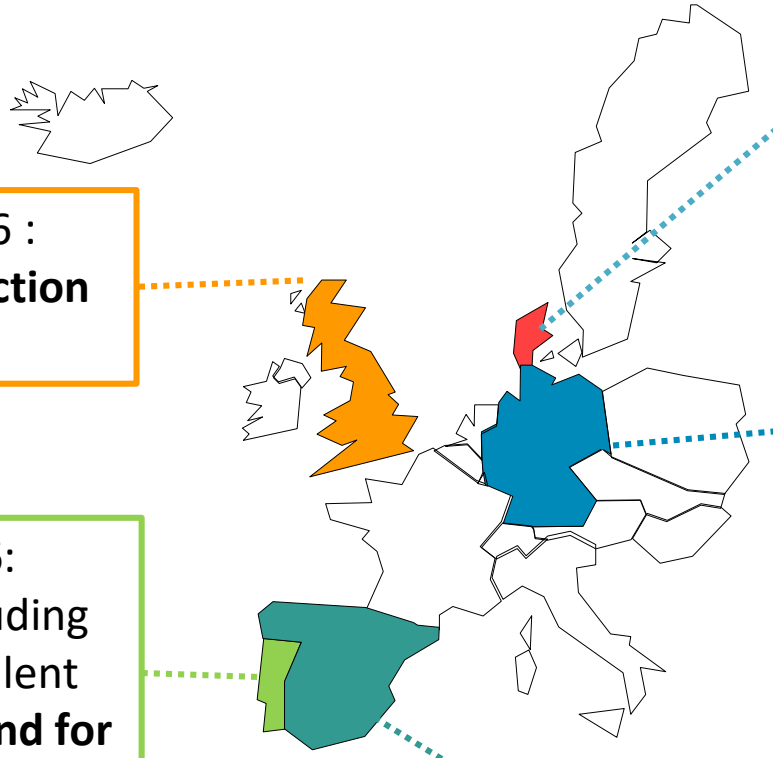
VRE share in annual electricity generation, 2016-22



Also in emerging economies and in large power systems the share of VRE is expected to double to over 10% in just five years.

Source: Renewable Energy Market Report, 2017

Notable milestones in RE integration



Scotland, 14 August 2016 : Daily **wind power production exceeded demand**

Denmark, 2 September 2015: The Western Danish power **system runs without centralised power generation** for the first time

Germany, 8 May 2016: **Wind and solar PV** cover the equivalent of **90% of power demand**

Portugal, 7-11 May 2016: **Renewable energy** (including hydro) covers the equivalent of **100% of power demand for 107 consecutive hours**

Spain, 28 February 2016: For the first time, **wind power provides upward balancing reserves**

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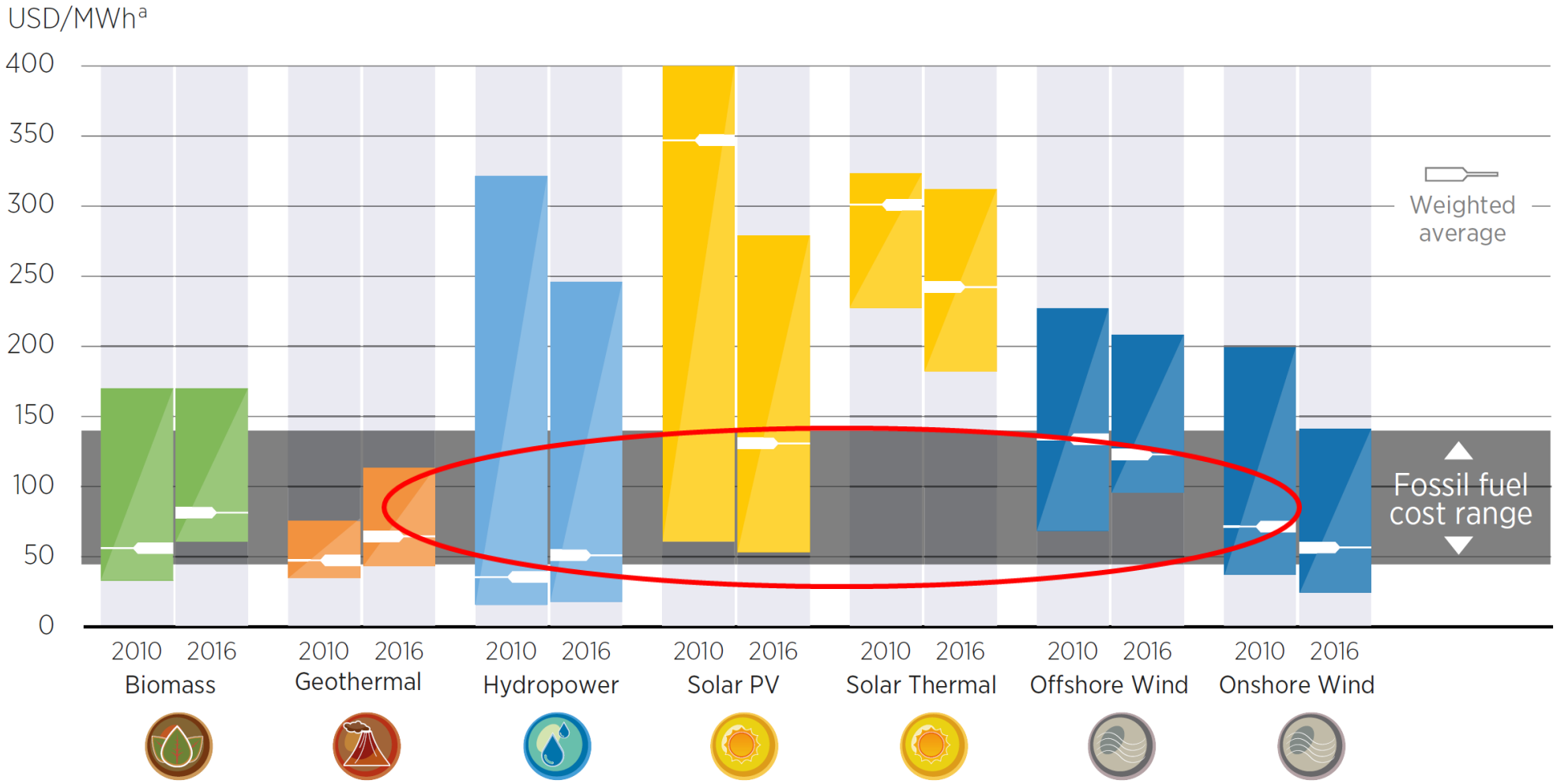
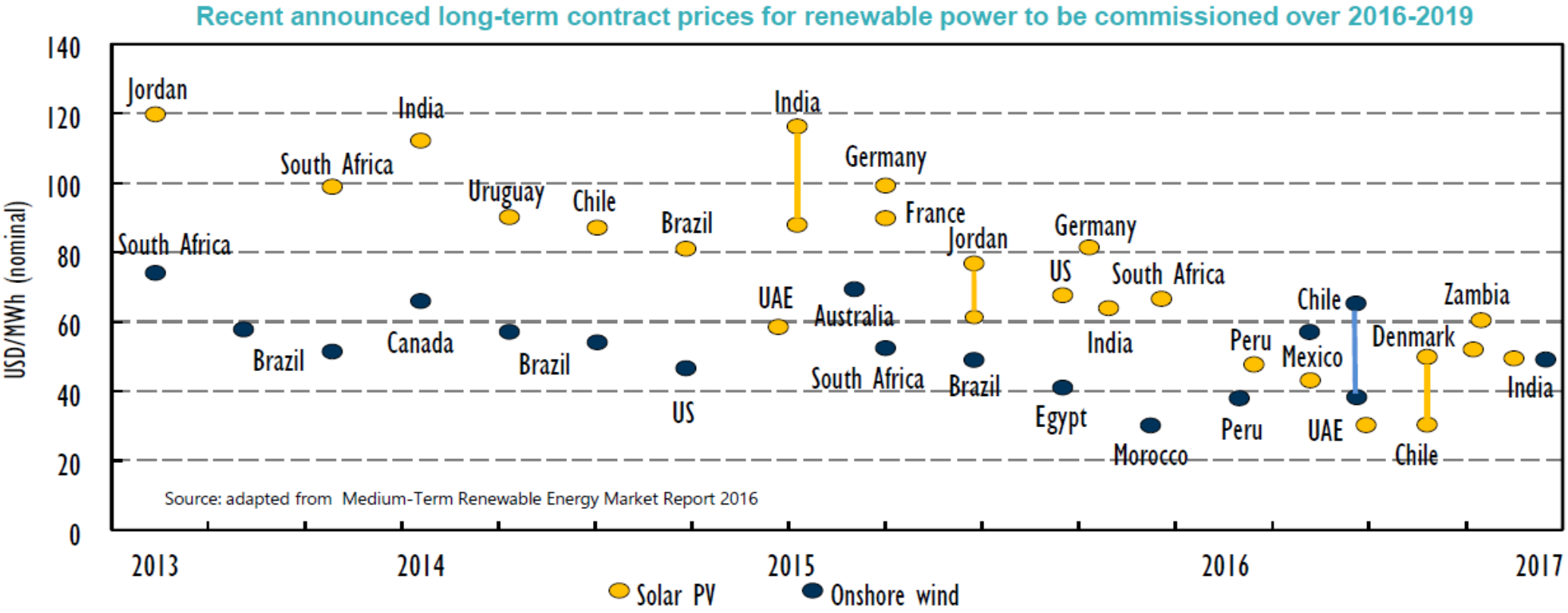
Levelised cost of electricity for utility scale power (ranges and averages)



Note: a) MWh: megawatt-hour
b) All costs are in 2016 USD. Weighted Average Cost of Capital is 7.5% for OECD and China and 10% for Rest of World

Source: IRENA (2017), REthinking Energy 2017: Accelerating the global energy transformation. International Renewable Energy Agency, Abu Dhabi.

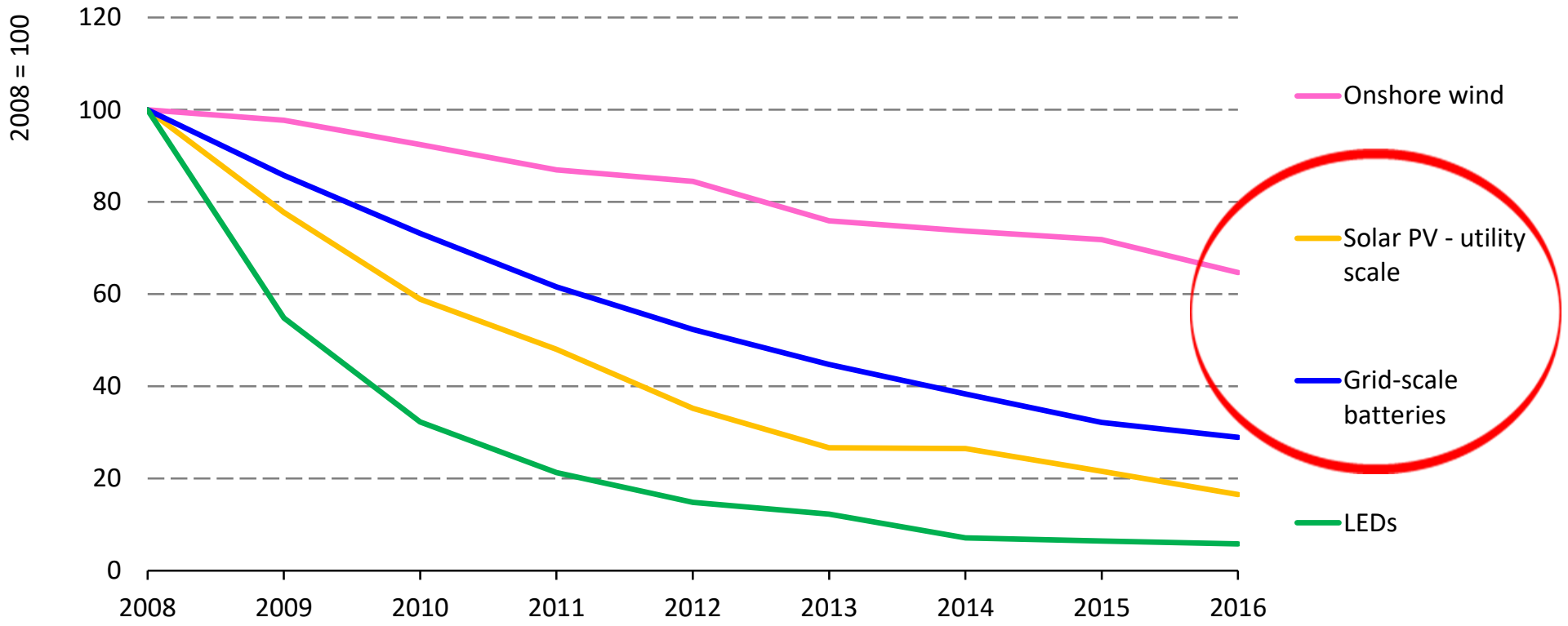
Wind and Solar PV prices declining



Best results occur where price competition, long-term contracts and good resource availability are combined

The cost of clean energy continues to fall

Indexed cost of onshore wind, utility scale PV, batteries and LED lighting, 2008-2015

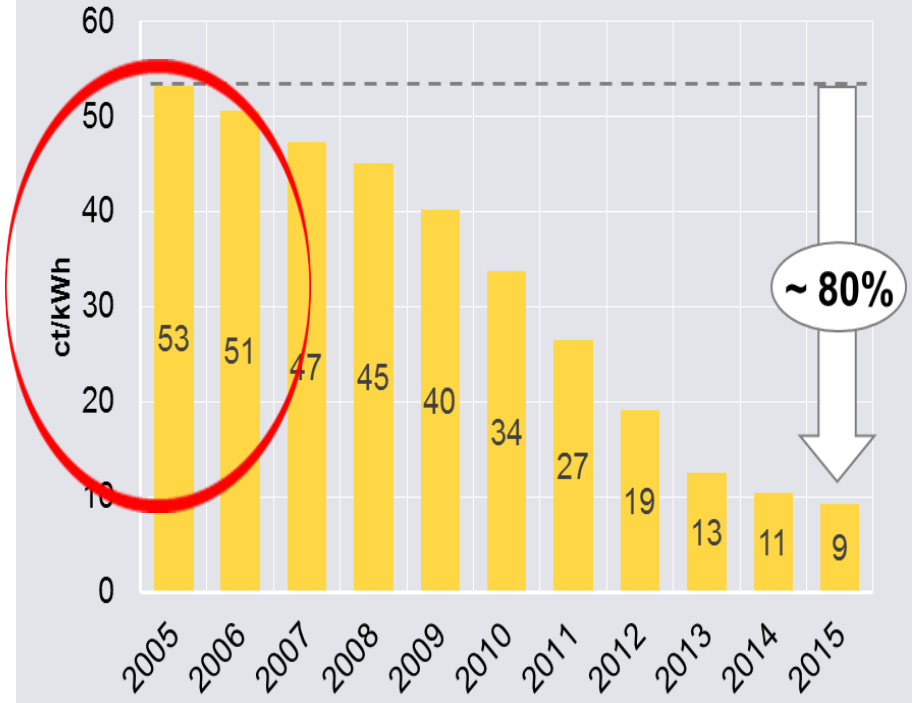


Source: adapted from World Investment Report 2016

PV and wind costs have fallen dramatically in recent years. The falling cost of clean energies opens new opportunities

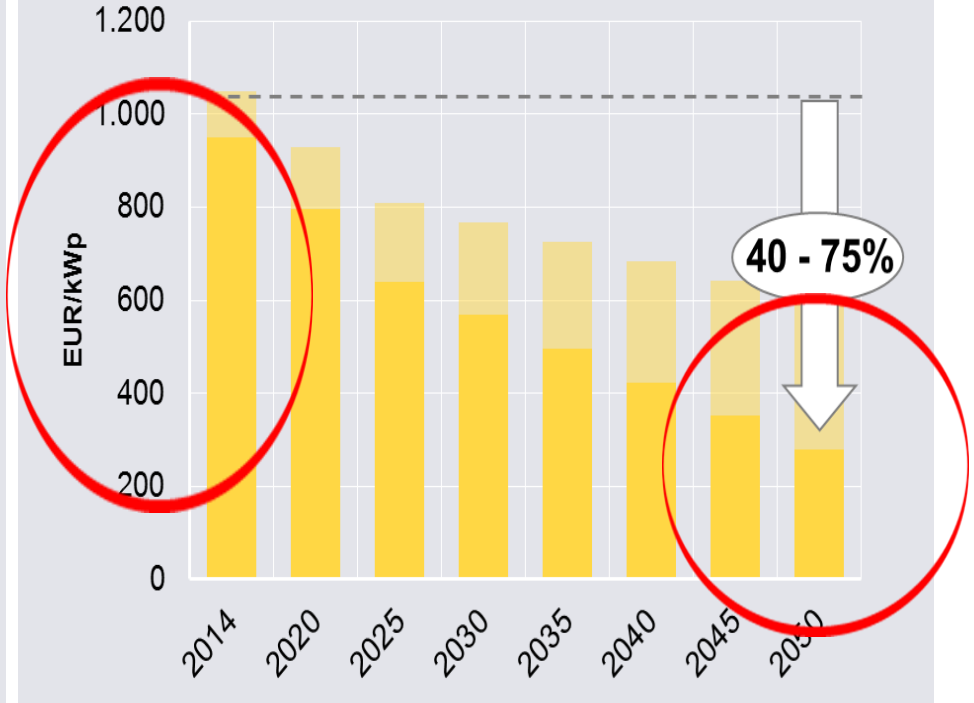
Example Germany: Feed-in tariffs for Solar PV dropped massively since 2005 - and cost degression will continue

Average PV feed-in tariff for new installations 2005 - 2015



ZSW et. al (2014), own calculations

Expected cost degression for large-scale PV systems 2014 - 2050



Fraunhofer ISE (2015)

Source: AGORA Dr. Patrick Graichen; Insights from Germany's Energiewende, Berlin 2016

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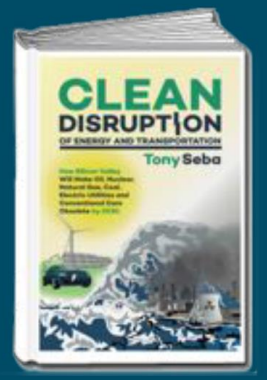
CLEAN DISRUPTION OF ENERGY & TRANSPORTATION

1. Energy Storage
2. Electric Vehicles
3. Self-driving Cars
4. Solar



Cost development of automotive batteries per kWh

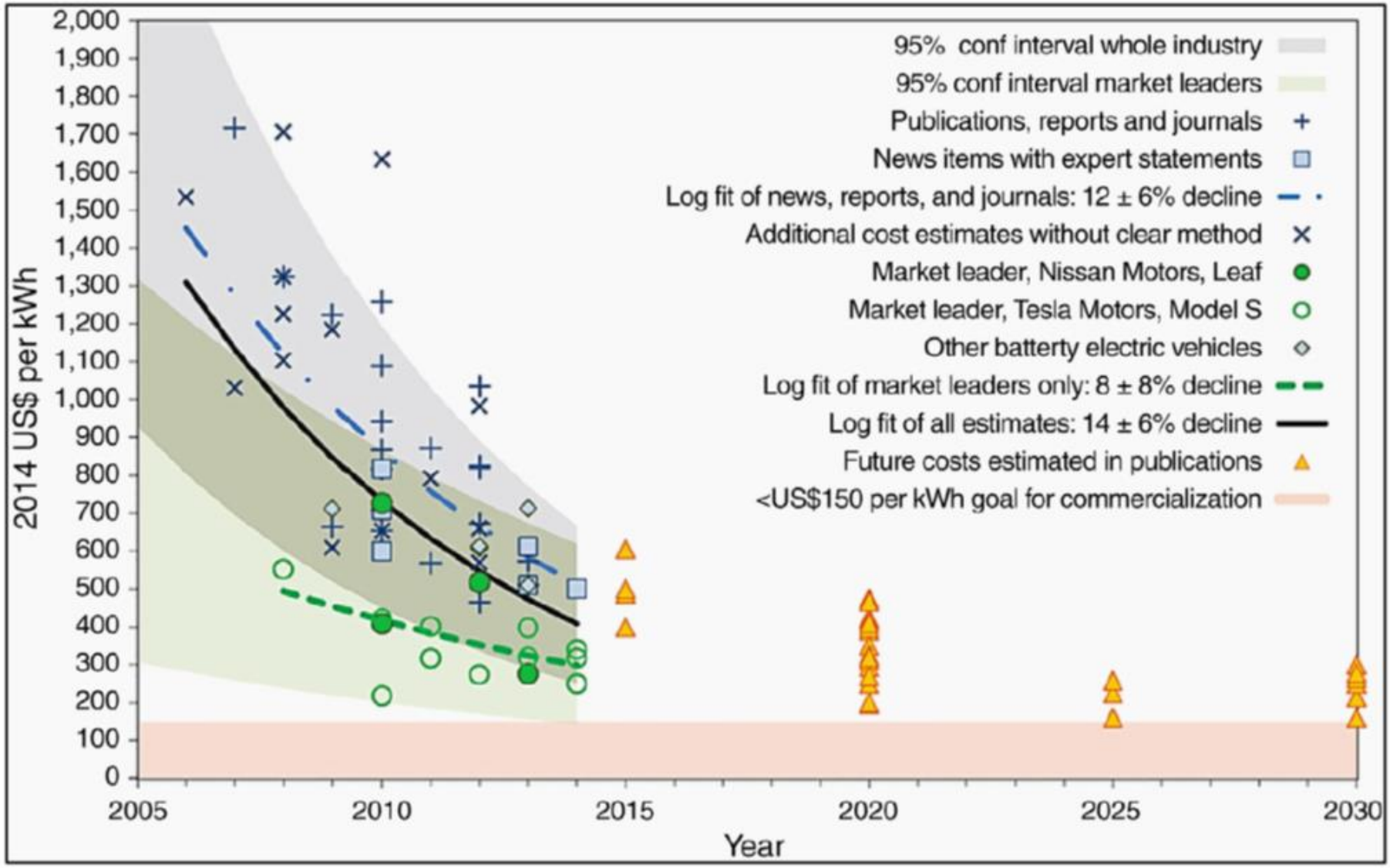
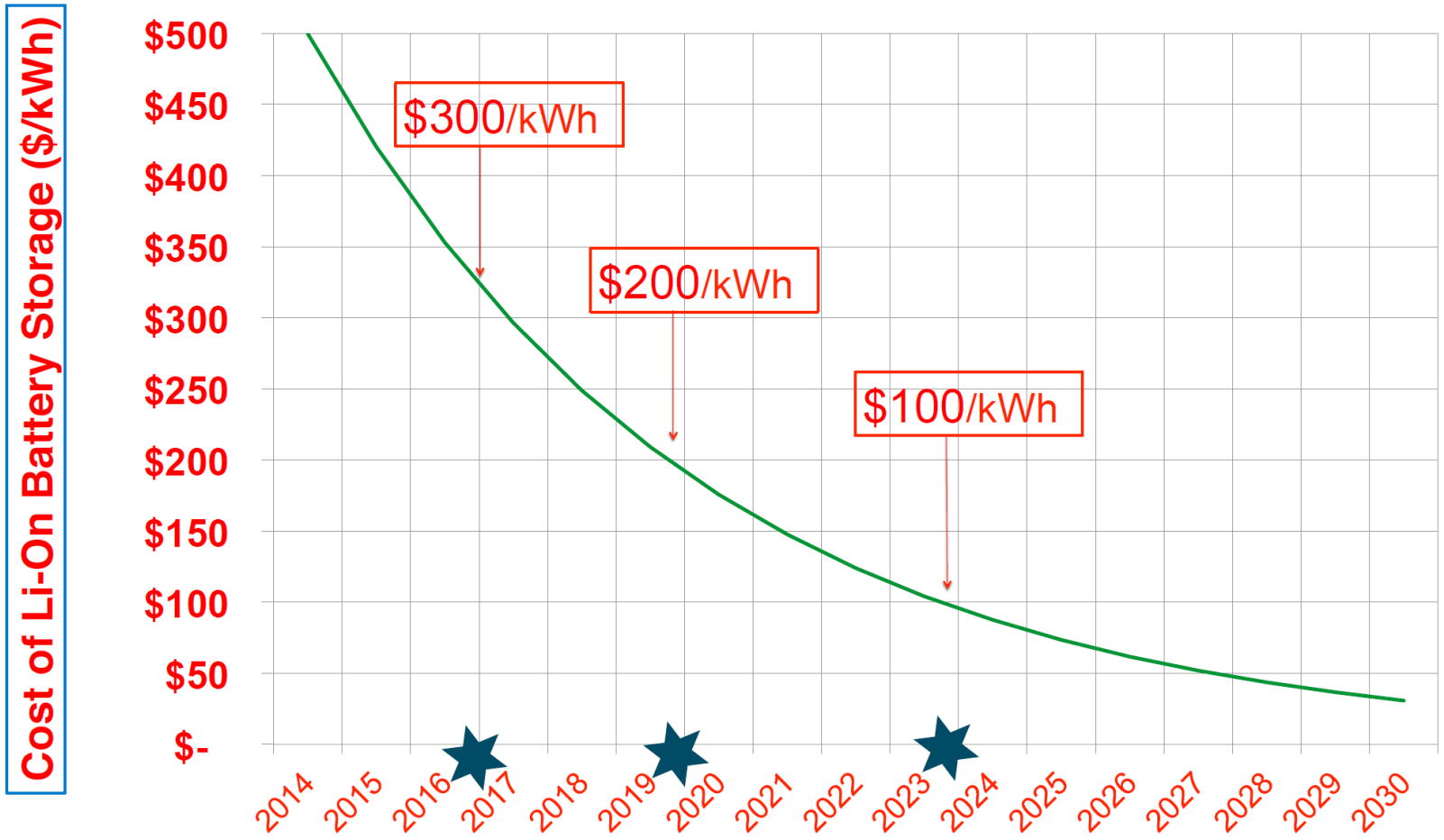


FIGURE 6.4 Projections for reduction in kWh costs of automotive battery. *(Source: Nykvist and Nilsson (2015).)*

Projected cost of Li-On Battery $/kWh



Assumption: 16% /year Technology Cost Curve

Source: Clean Disruption

Volkswagen unveils its first long-distance electric car

Concept product joins intensifying race to build zero-emission vehicle for mass market; 28.9.2016

https://www.ft.com/content/07ae79e6-8586-11e6-a29c-6e7d9515ad15

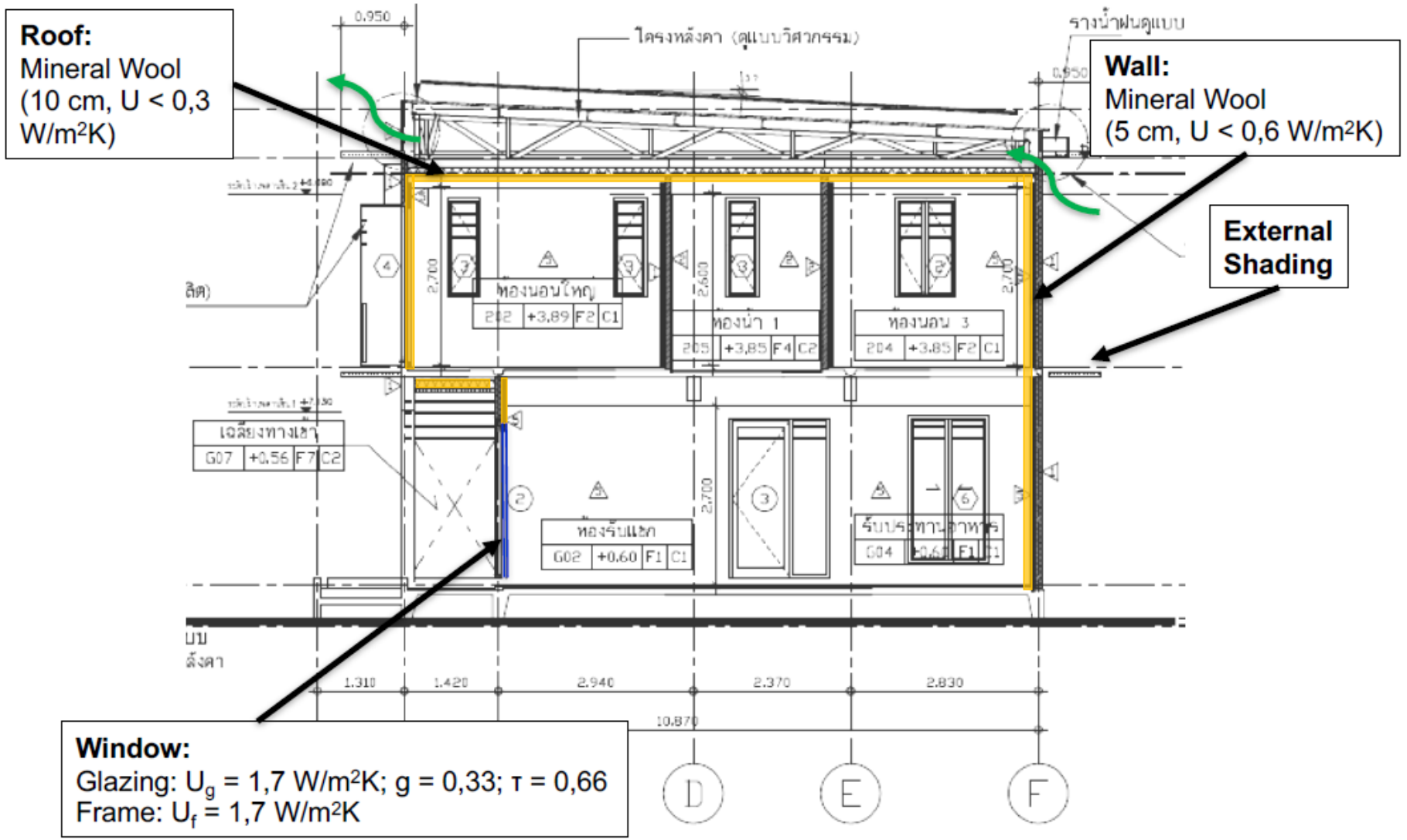
Tesla Energy Sun Home Wheels
Combination of Home Energy and Transport

Source: https://www.teslarati.com/tesla-energy-sun-home-wheels/

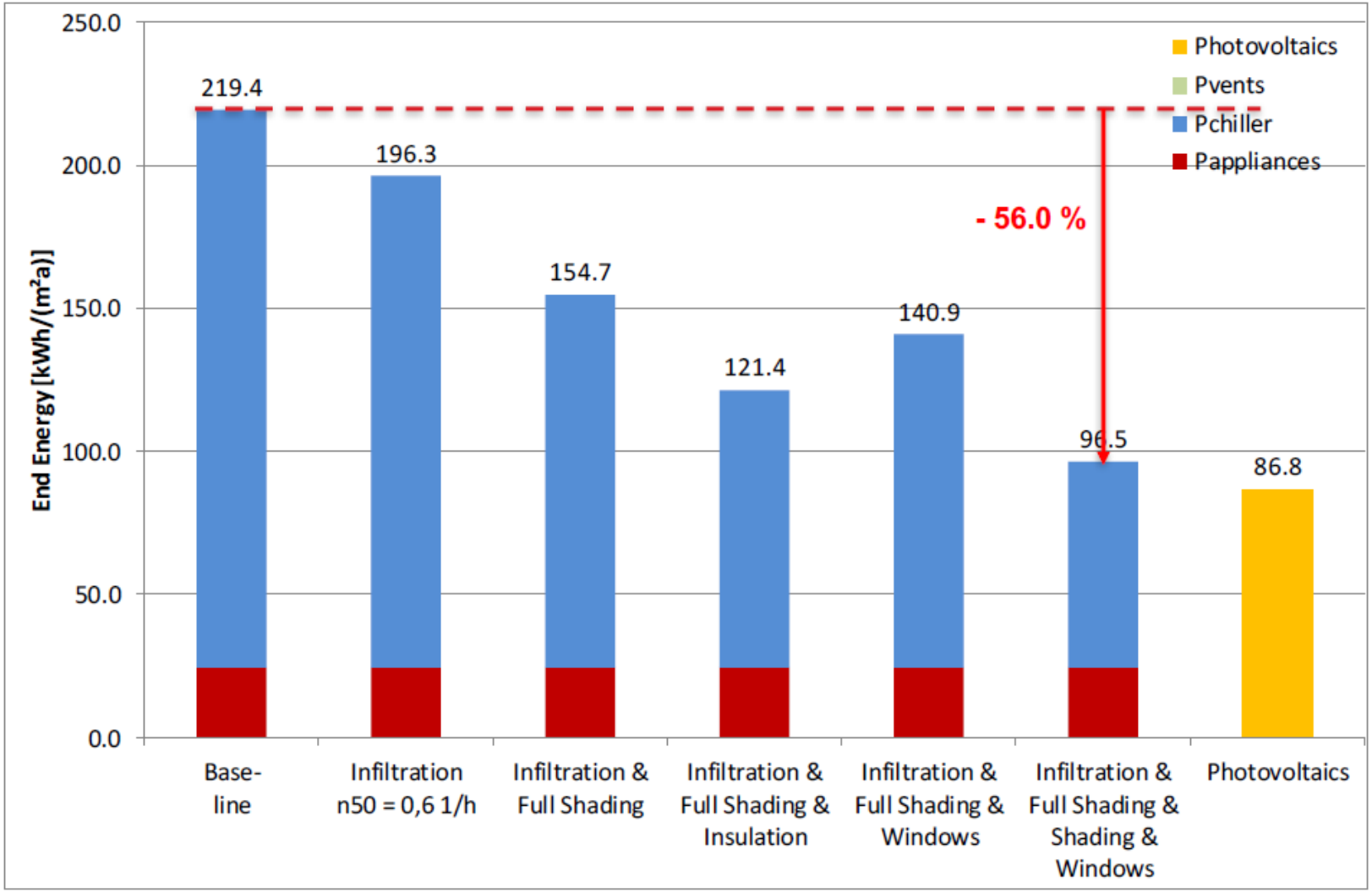
Example from Bangkok, Thailand: Zero Energy town house with PV and Ice Storage

Pruksa+ House (finished 31.10.2016)

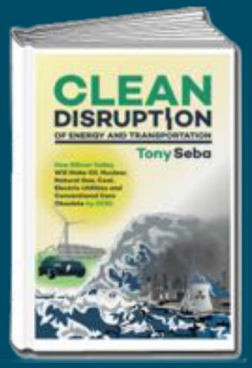
Building Physics



Simulation Study about Passive Measures (early project stage)



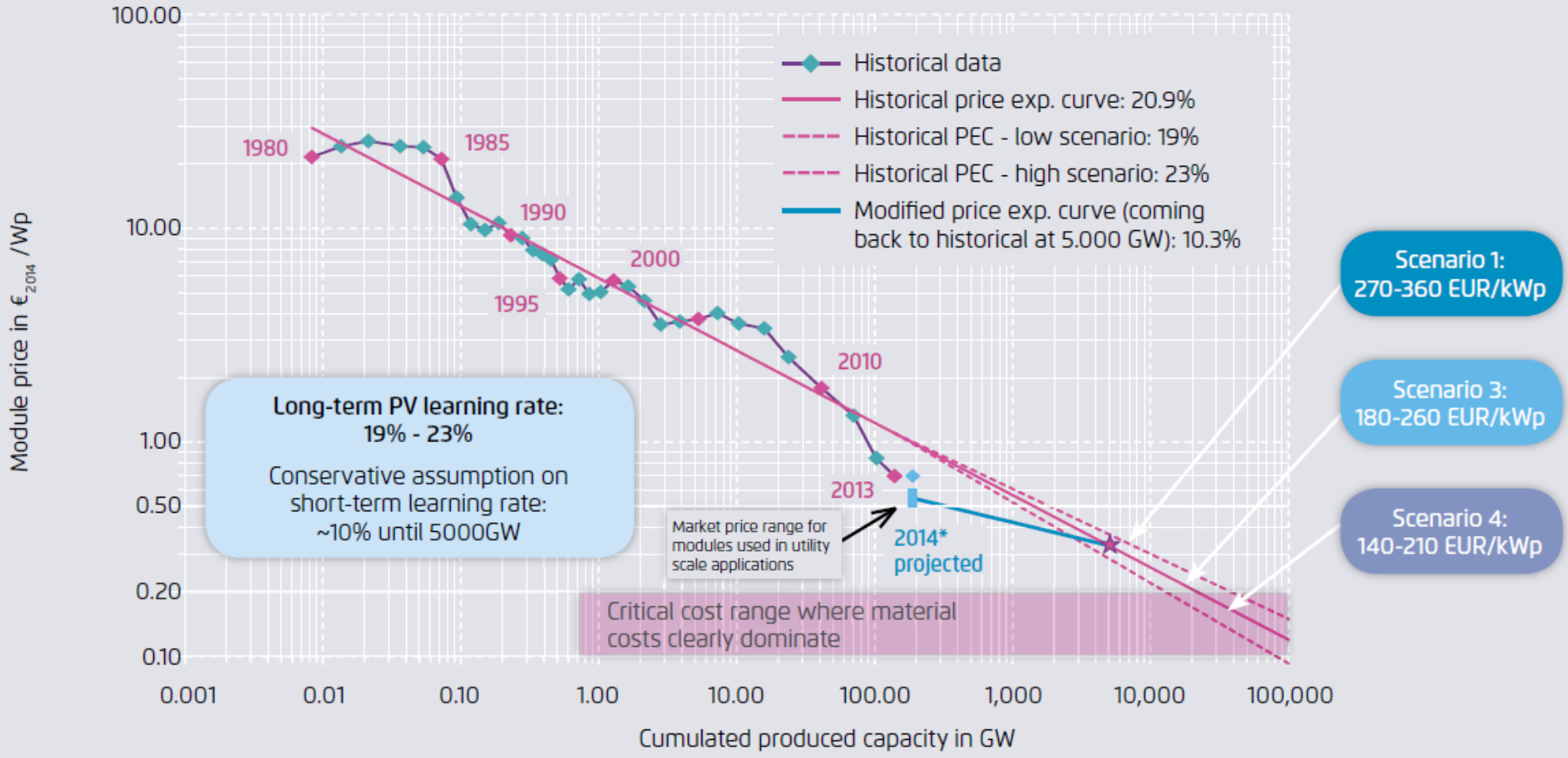
4 The Solar Disruption



abc7news.com

PV costs follow usual world wide semi-conductor cost developments!

Future module prices in different scenarios based on the historical "learning rate" Figure E2



Fraunhofer ISE, own illustration

Source: Agora Energiewende: Current and Future Cost of Photovoltaics, 2015

Summary: Four Clean Energies - Disruptive Technology Trends

- **Solar Photovoltaic (PV)** costs fell dramatically in the last years and will continue to fall further!
  - Germany: by 80% in 10 years
  - World's lowest bid: Abu Dhabi, 09/2016: 2,42 cUS$/kWh for 350 MWp
- **Energy Storage Technologies** seem to follow the learning curve of PV module costs
- **Electrical Vehicles (EV)** are entering the markets
- **Self driving cars** and **shared mobility concepts** start

→ This together will lead to massive **"Clean Disruption**" of energy and transportation sector by 2030

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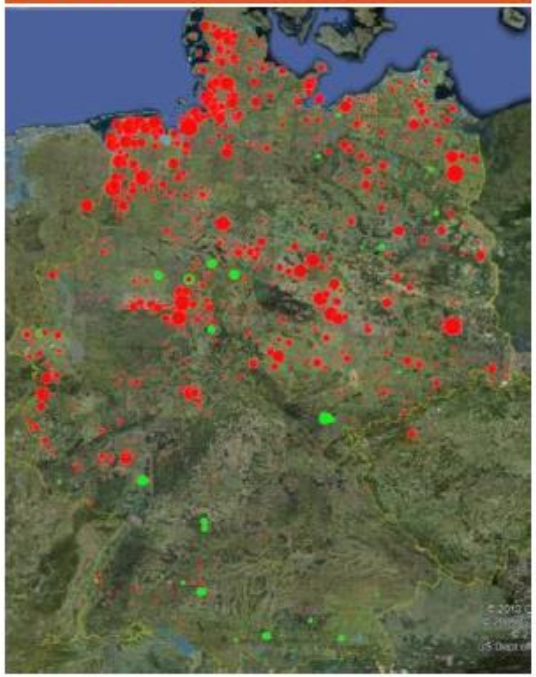
RES development in Germany

2000

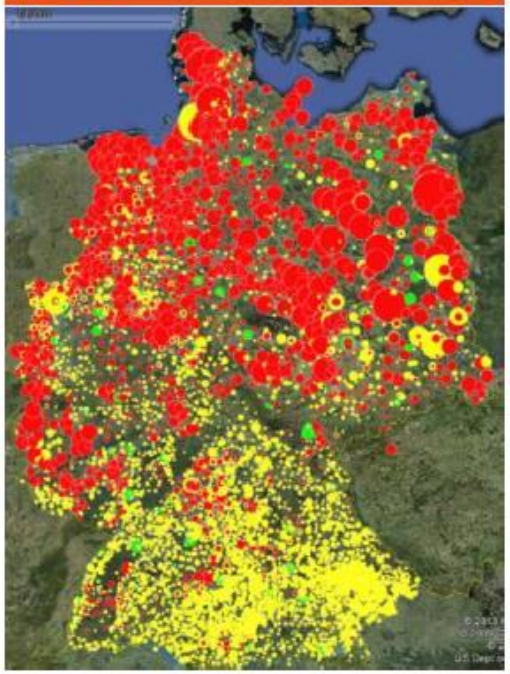


- ~ 30,000 plants
- 1.665* MW installed Wind in Germany

2006

- ~ 221,000 plants
- 2.233* MW installed Wind in Germany

2016



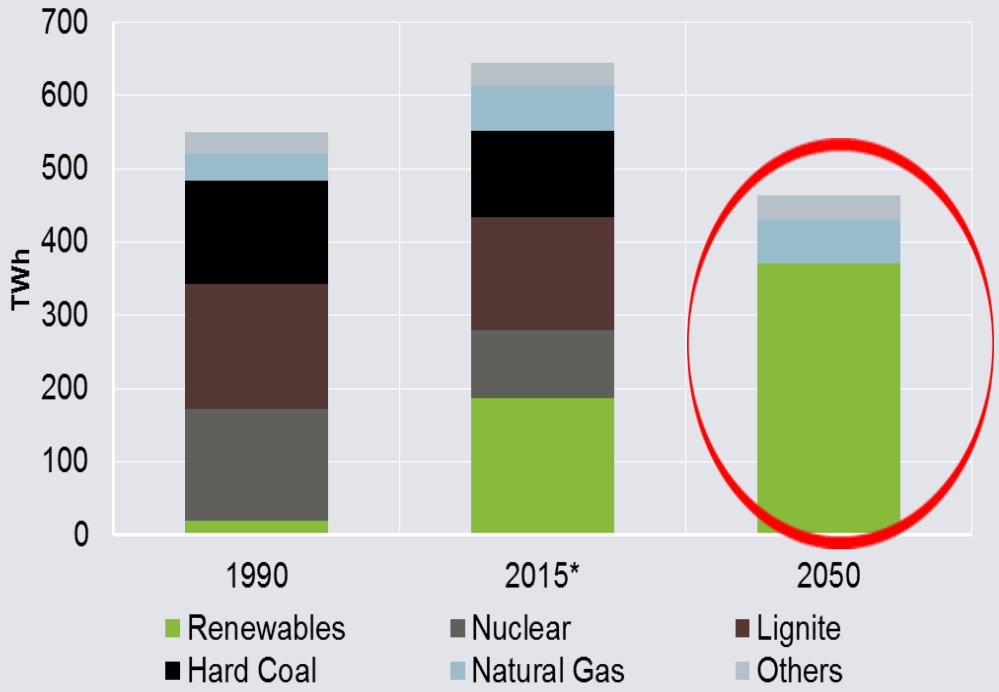
- ~ 1,600,000 plants
- 45.910* MW installed wind in Germany

Massive RES growth in Germany since the introduction of the Renewables Energy Law (EEG) in 2000 – with Wind and PV as the main growth drivers

PV Wind Biomass * BWE Figures Markierungen proportional zur installierten Leistung

The Energy transition means fundamentally changing the whole power system

Gross electricity generation 1990, 2016 and 2050



AGEB (2016), BReg (2010), EEG (2014), own calculations * preliminary

Phase out of Nuclear Power
Gradual shut down of all nuclear power plants until 2022

Reduction of Greenhouse Gas Emissions
Reduction targets below 1990 levels:
- 40% by 2020; - 55% by 2030; - 70% by 2040;
- 80% to - 95% by 2050

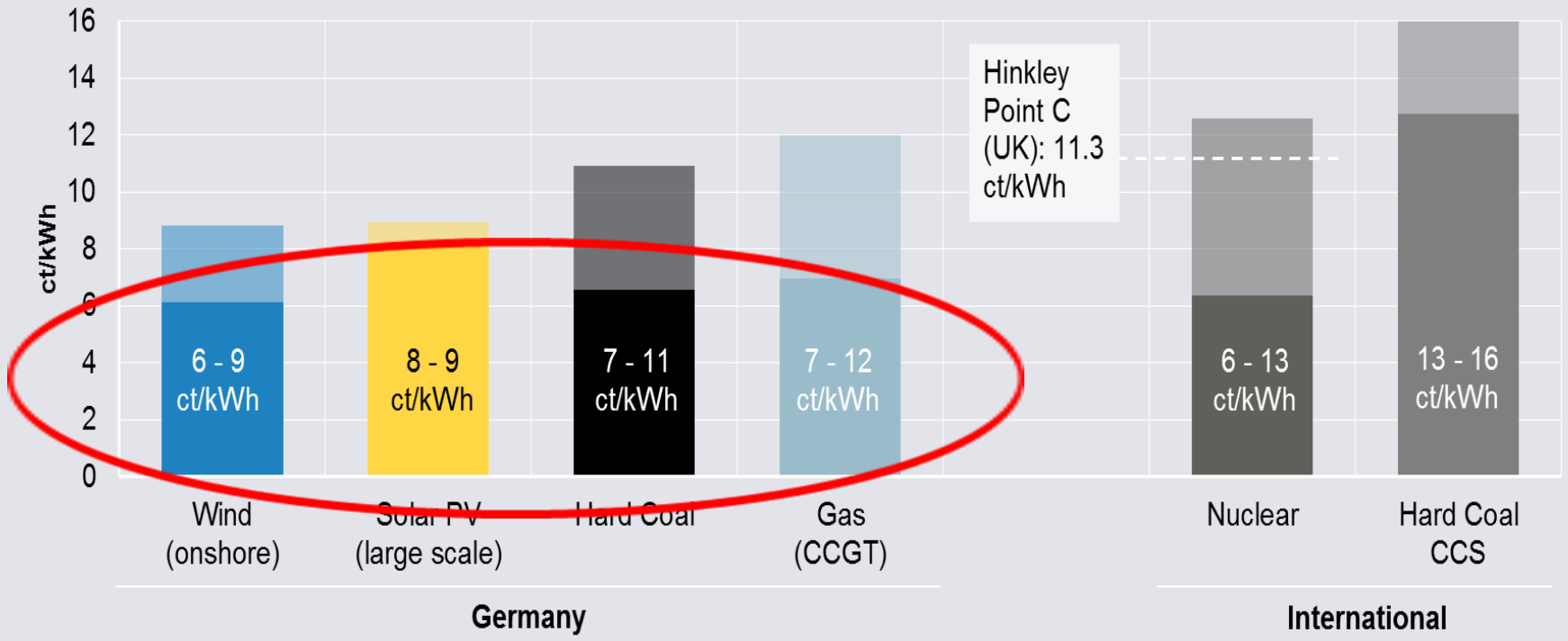
Development of renewable energies
Share in power consumption to increase to:
40 - 45% in 2025; 55 - 60% in 2035; ≥ 80% in 2050

Increase in efficiency
Reduction of power consumption compared to 2008 levels: - 10% in 2020; - 25% in 2050

Source: AGORA Dr. Patrick Graichen; Insights from Germany's Energiewende, Berlin 2016

Today, wind and solar are already cost competitive to all other newly built power plants in Germany

Range* of levelized cost of electricity (LCOE) 2015



Agora Energiewende (2015e)

* based on varying utilization, CO_2-price and investment cost

Source: AGORA Dr. Patrick Graichen; Insights from Germany's Energiewende, Berlin 2016

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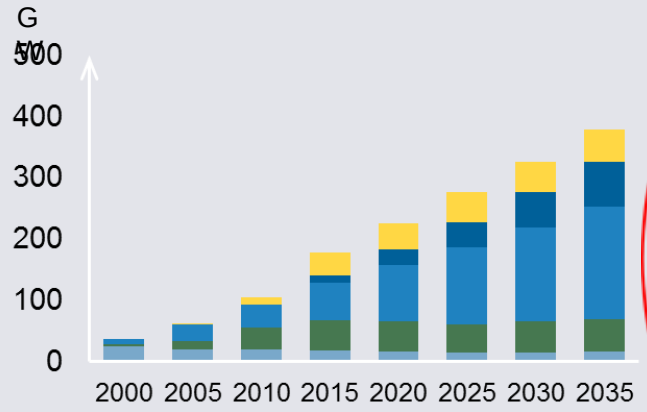
With wind and solar, the new power system will be based on two technologies that completely change the picture

Gross electricity generation of renewable energies 2000 - 2035

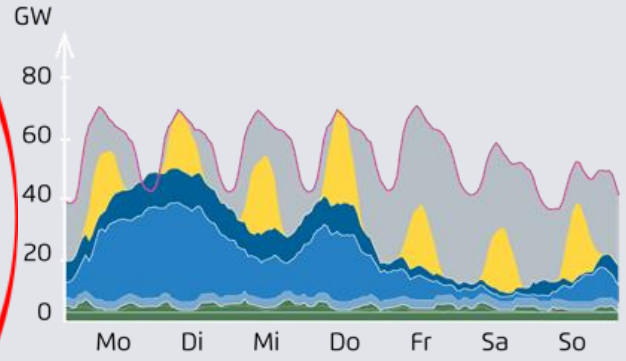


AGEB (2015a), BNetzA (2014), BNetzA (2015b), own calculations

Specific characteristics of Wind and Solar PV

1. Variable
2. High capital costs
3. Very low variable cost

Electricity generation and consumption in a sample week 2023



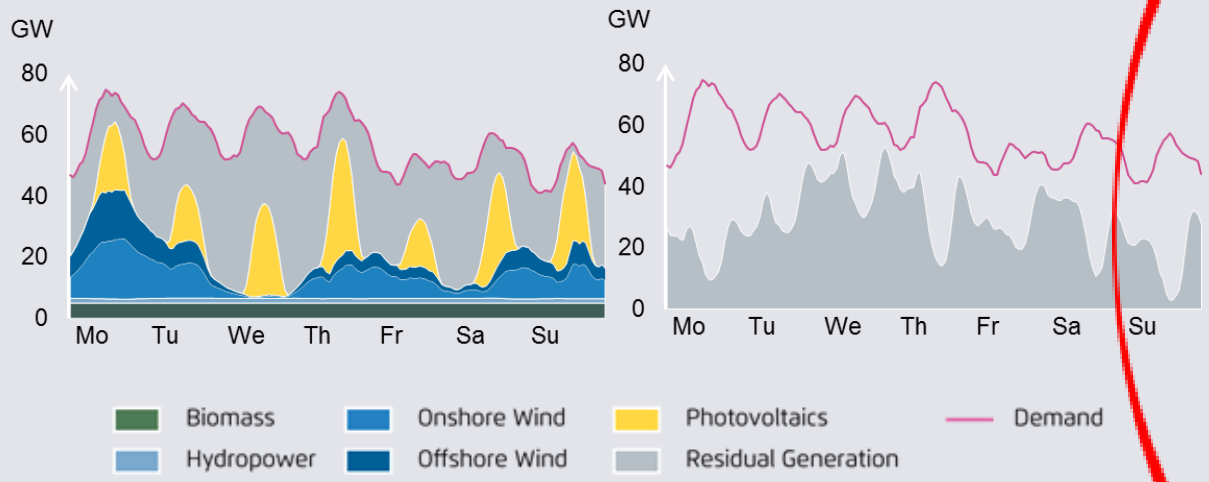
Fraunhofer IWES (2013)

Source: AGORA Dr. Patrick Graichen; Insights from Germany's Energiewende, Berlin 2016

Flexibility is the paradigm of the new power system – baseload capacities are hardly needed in longer future

=> That has consequences for new coal power plants!
Get flexibel!

Electricity generation and consumption in a sample week with 50% RES share



Own calculations on basis of Agora Energiewende (2015b)

Key flexibility options

- **Flexible fossil and bioenergy power plants (incl. CHP)**
- **Grids and transmission capacities for exports/imports**
- **Demand Side Management**
- **Storage technologies (Batteries, Power-to-Gas)**
- **Integration of the power, heat and transport sectors (power-to-heat, electric cars)**

Source: AGORA Dr. Patrick Graichen; Insights from Germany's Energiewende, Berlin 2016

Composition of conventional power park in Germany for 0% and for 40% variable RE power

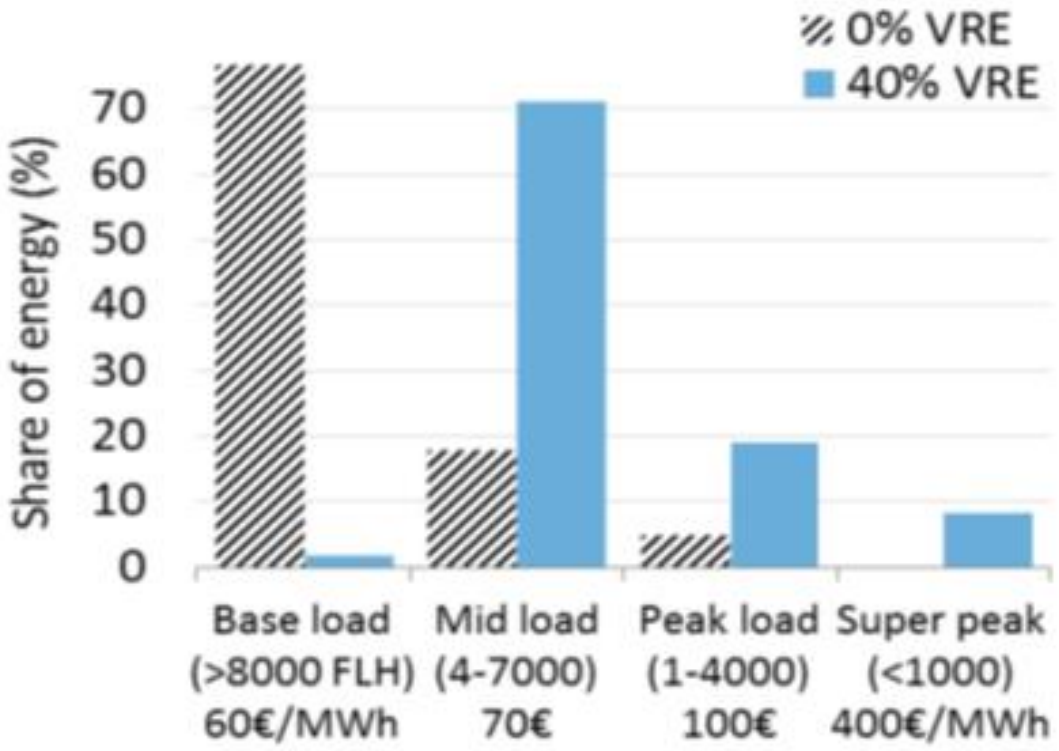
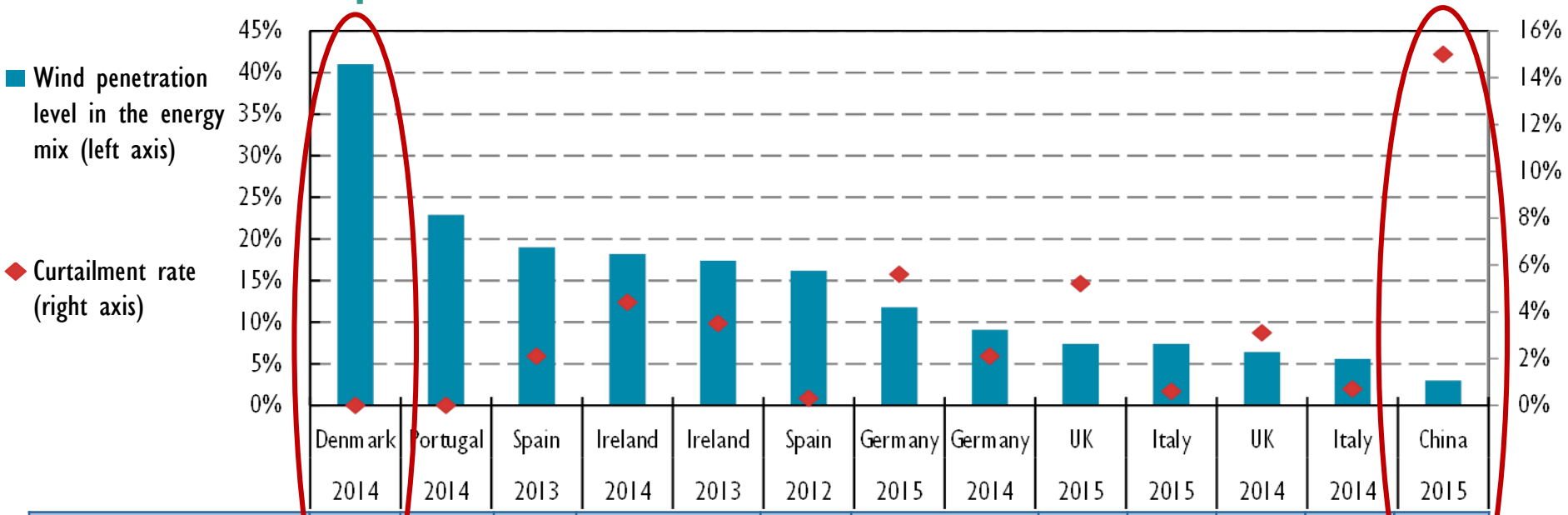


Figure 9: Utilization of residual capacity without renewables and at 40% penetration. Electricity generated in base load plants strongly decreases, while mid and peak load generation increase (not only relatively, also absolutely).

:Source: Hirth, Lion, Falko Ueckerdt & Ottmar Edenhofer (2015): "Integration Costs Revisited – An economic framework of wind and solar variability", Renewable Energy 74, 925–939. doi:10.1016/j.renene.2014.08.065

System integration strategies key to use wind and solar effectively

Wind penetration and curtailment in selected countries, 2012-2015

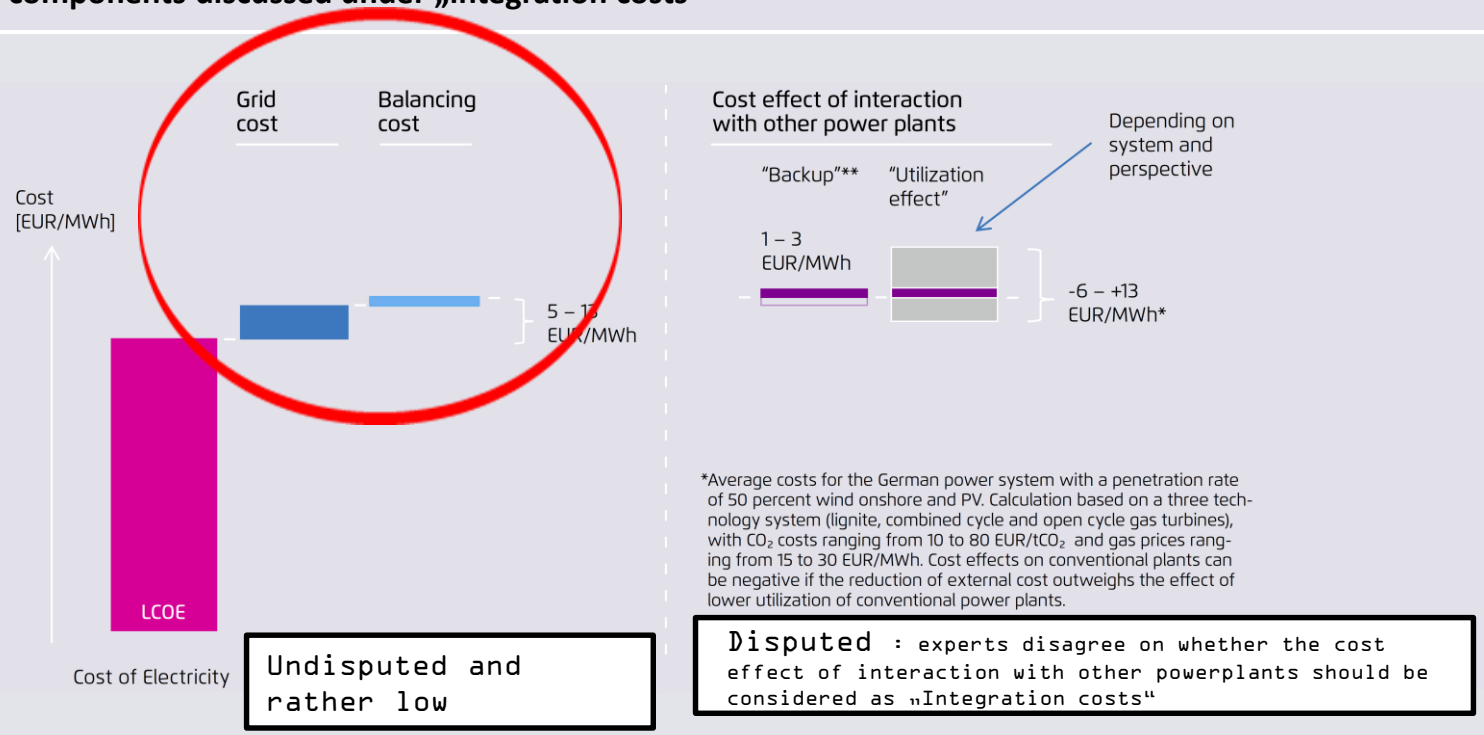


	Denmark 2014	Portugal 2014	Spain 2013	Ireland 2014	Ireland 2013	Spain 2012	Germany 2015	Germany 2014	UK 2015	Italy 2015	UK 2014	Italy 2014	China 2015
Grids	+	+	+	o	+	o	o	o	o	o	o	o	
Generation	+	+	+	+	+	o	o	+	o	+	+	-	
Operation	+	+	+	+	+	+	+	+	+	+	+	-	

Curtailment levels are a good indicator for successful VRE integration – growing curtailment signals shortfalls in power system flexibility

The integration costs of wind and solar (0.5 to 2.0 centsEuro/kWh) do not change their overall competitiveness

Overview of components discussed under „integration costs“

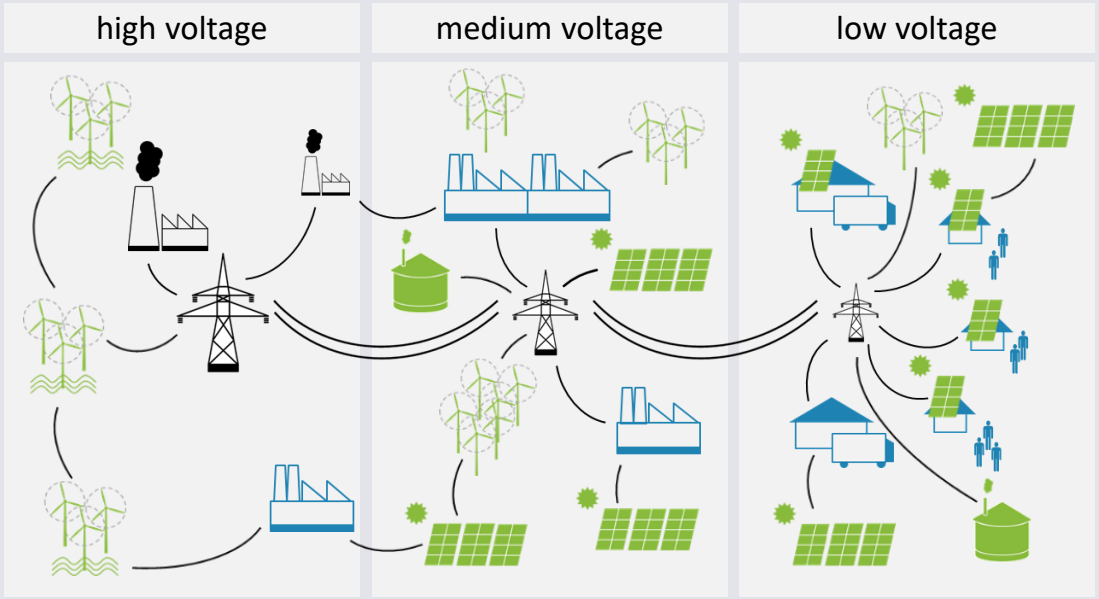


Source: AGORA Dr. Patrick Graichen; Insights from Germany’s Energiewende, Berlin 2016

Agora Energiewende (2015)

The Energy transition implies a new energy world – characterized by flexibility, decentralized structures and a wide variety of actors

Illustrative visualisation of the old and the new electricity system



Own illustration

Source: AGORA Dr. Patrick Graichen; Insights from Germany's Energiewende, Berlin 2016

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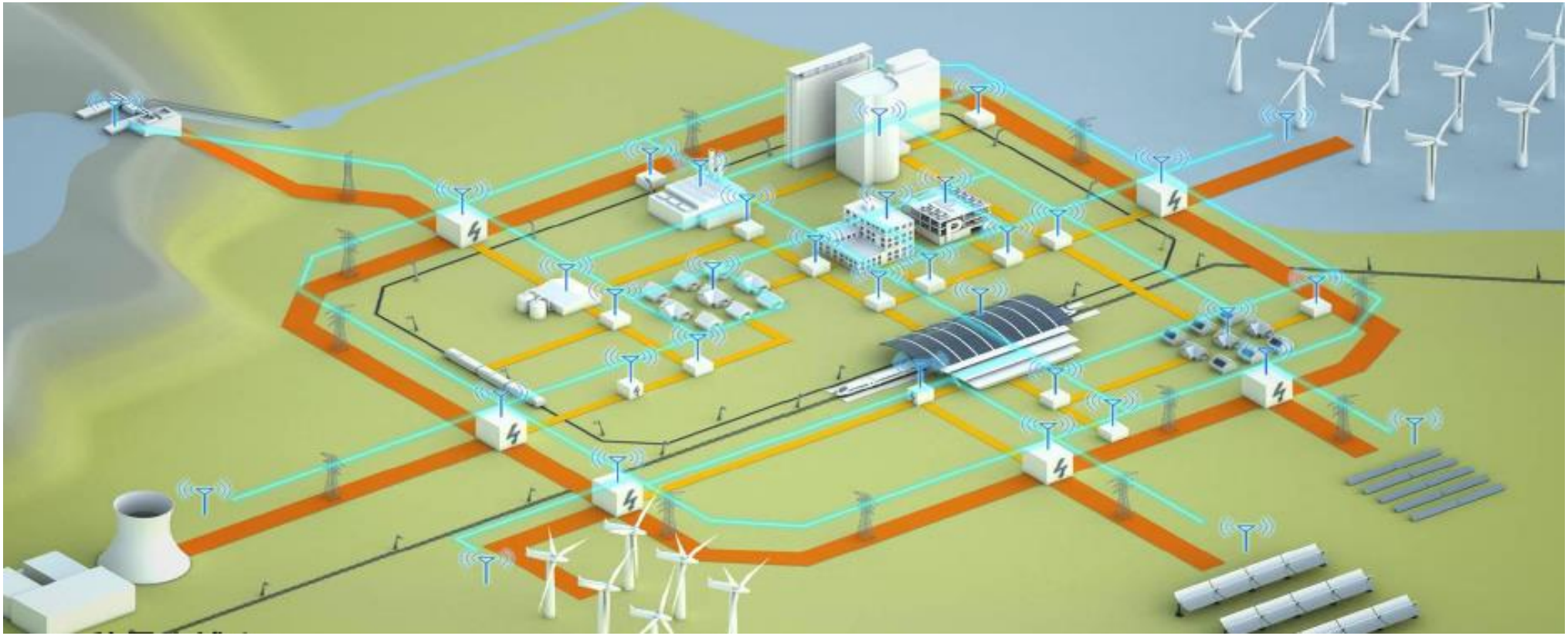
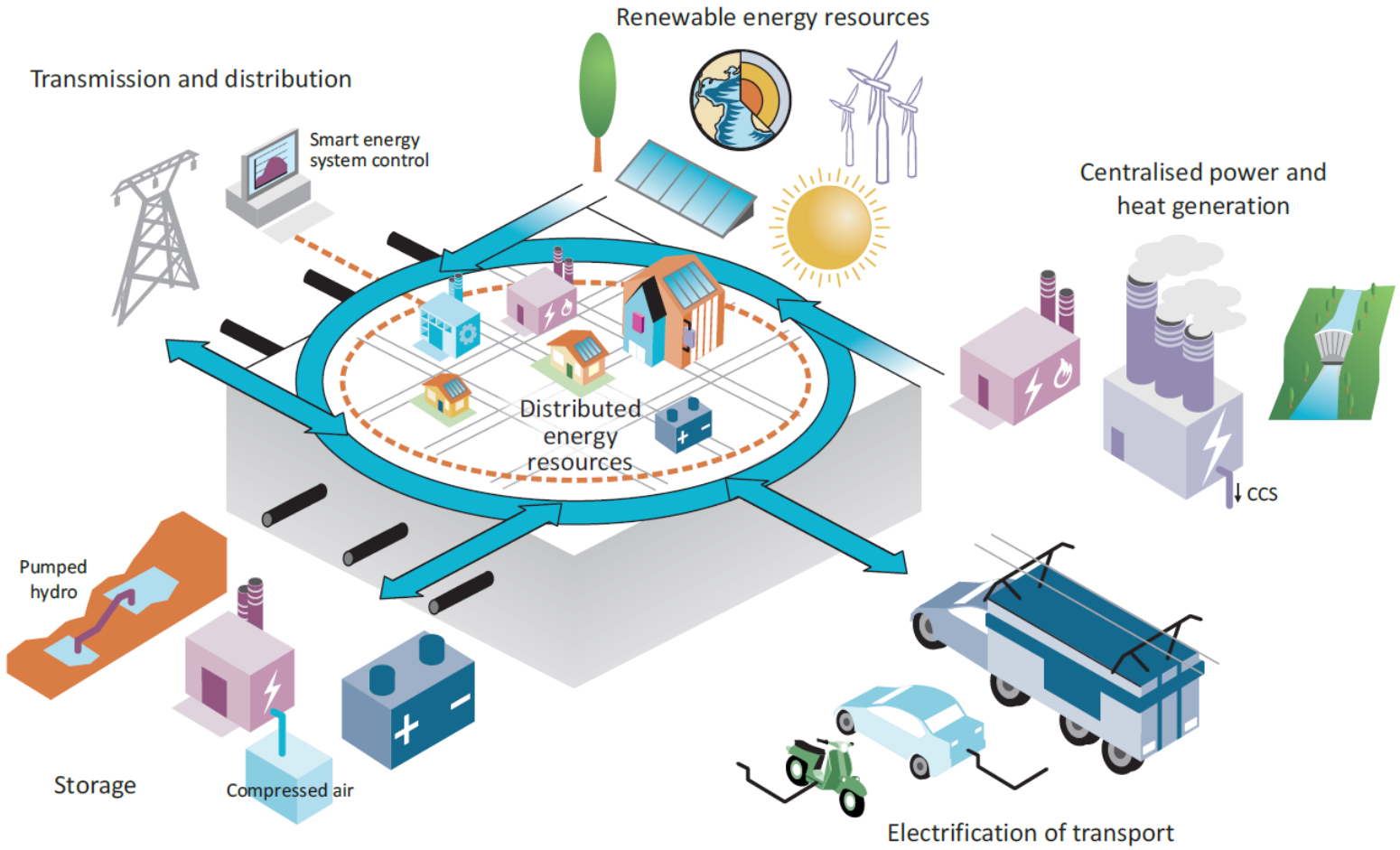
How does the future energy system look like?
Nobody knows it exactly,
but it will be very different from today!
So better be flexible and prepare for the future!

Source: Siemens AG



Putting together the pieces – towards a new paradigm?



Smart local grids, linking a diverse set of distributed resources across different sectors, may emerge as main pillar of future energy systems.

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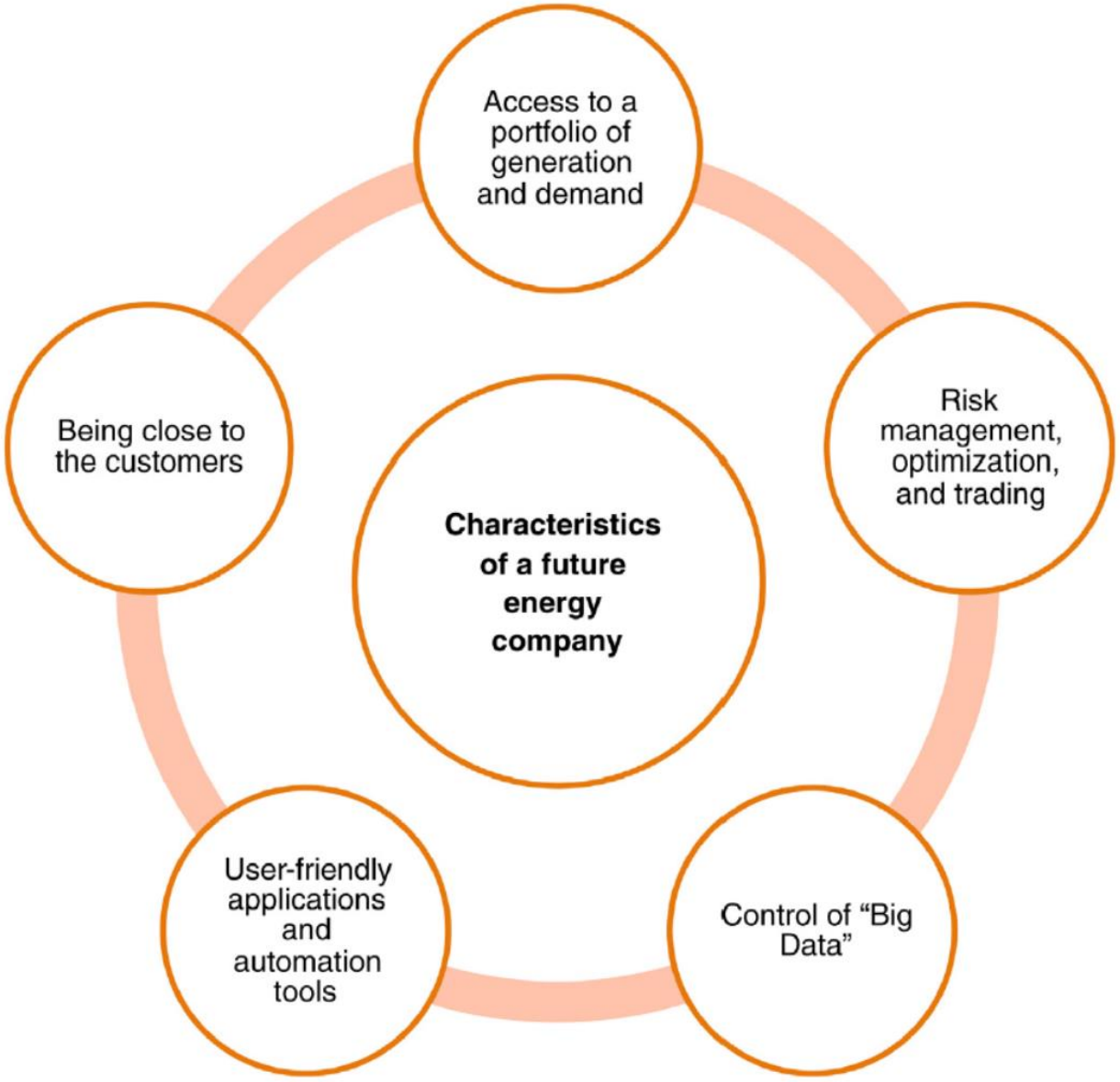

FIGURE 2.4 Five characteristics of future integrated energy company.

Source: Fereidoon P. Sioshansi; Innovation and Disruption at the Grid's Edge, Menlo Energy Economics, Walnut Creek, CA, United States (2017)

FIVE KEY CHARACTERISTICS OF A FUTURE **ENERGY COMPANY**

1: **Access to a portfolio of generation**, storage, and flexible demand will remain important in the future, but with less emphasis on asset ownership.

2: **Risk management, optimization, and trading** are essential parts of the operation of a utility and will continue to be core business.

3: **Control of "Big Data"** will give leverage for competitive advantage.

4: **User-friendly applications and automation** tools will enhance customer propositions and unlock demand response.

5: **Being close to the customers** and retaining their trust as their needs change will be important to unlock new sources of value.

Source: Fereidoon P. Sioshansi; Innovation and Disruption at the Grid's Edge, Menlo Energy Economics, Walnut Creek, CA, United States (2017)

FIGURE 3.2 PwC's new market paradigm.

Source: Fereidoon P. Sioshansi; Innovation and Disruption at the Grid's Edge, Menlo Energy Economics, Walnut Creek, CA, United States (2017)

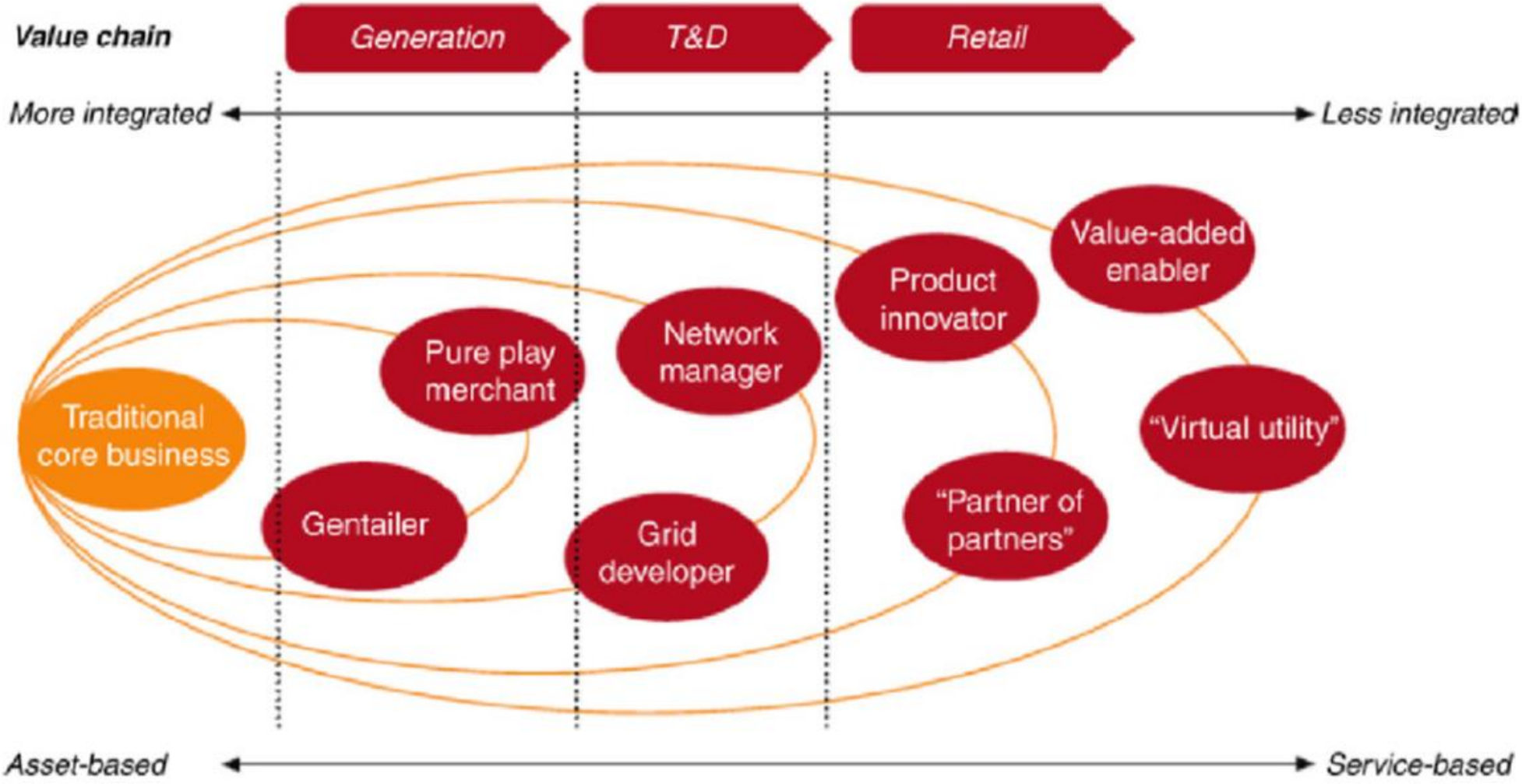

FIGURE 3.3 PwC's business model choices.

Source: Fereidoon P. Sioshansi; Innovation and Disruption at the Grid's Edge, Menlo Energy Economics, Walnut Creek, CA, United States (2017)

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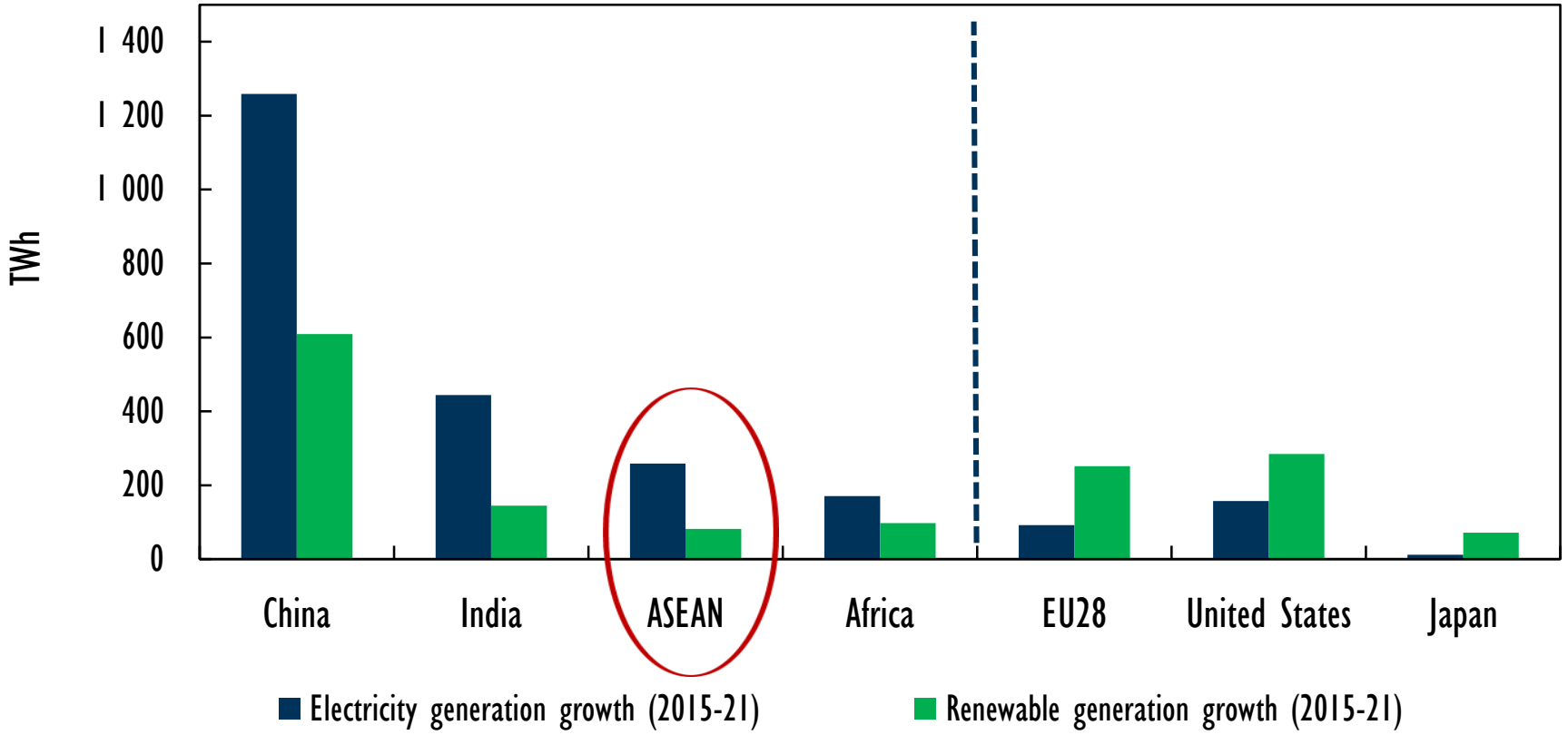
A two-speed world for renewable electricity

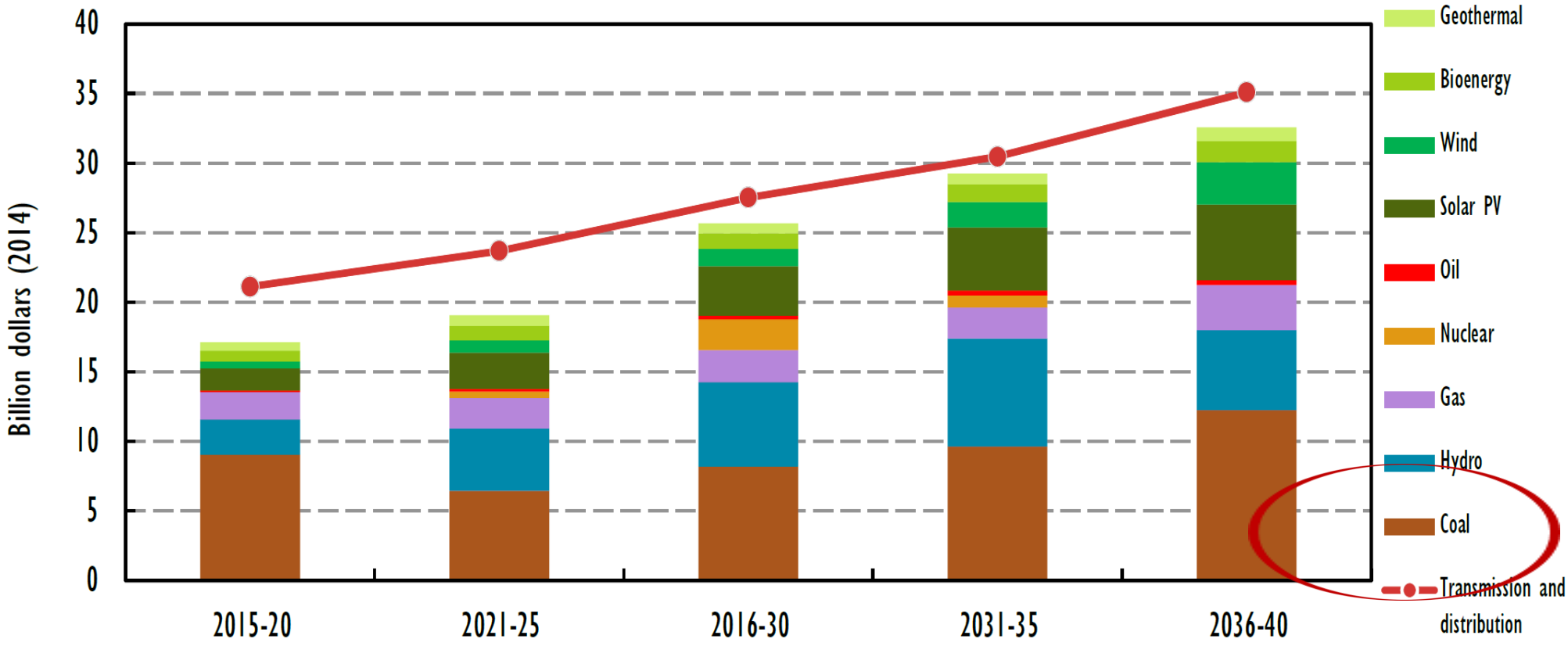
Electricity and renewable generation growth by country/region



Source: Total electricity generation from World Energy Outlook 2016.

The increase in generation from renewables in 2015-2021 represents 60% of the global increase in electricity output, but prospects vary across regionally

Average annual investment in the power sector in ASEAN countries



Source: IEA (2015a), *World Energy Outlook Special Report 2015: Southeast Asia Energy Outlook*, OECD/IEA, Paris.

ASEAN electricity generation by source (TWh) –

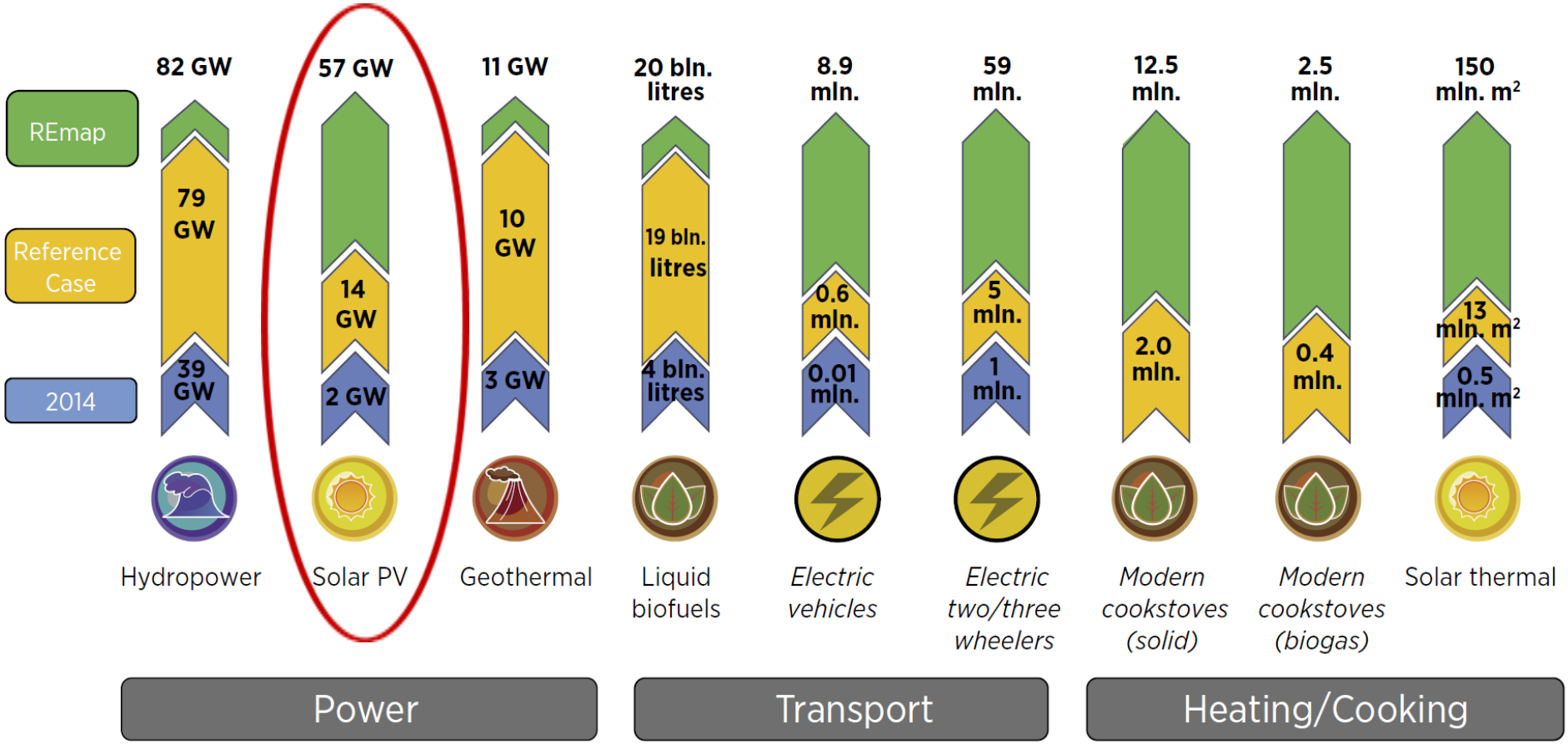
Coal grow to 50%, Gas reduced to 26%, RE to 22% in 2040

Germany now 37%, 65% until 2030

Source	Share				2013-40	Share	
	1990	2013	2020	2040		2013	2040
Fossil fuels	120	648	925	1 731	3.6%	82%	77%
Coal	28	255	482	1 097	5.6%	32%	50%
Gas	26	349	406	578	1.9%	44%	26%
Oil	66	45	45	24	-2.2%	6%	1%
Nuclear	0	0	0	32	n/a	0%	1%
Renewables	34	141	180	481	4.7%	18%	22%
Hydro	27	110	119	255	3.2%	14%	12%
Geothermal	7	19	27	58	4.2%	2%	3%
Bioenergy	1	10	22	75	7.7%	1%	3%
Other	0	1	12	93	16%	0%	4%
Total	**154**	**789**	**1 104**	**2 212**	**3.9%**	**100%**	**100%**

Soure: OECD/IEA 2015 Development Prospects of the ASEAN Power Sector

ASEAN: Physical capacity growth of select renewable technologies in the Reference Case and REmap Options to 2025



Source: IRENA & ACE (2016). Renewable Energy Outlook for ASEAN: a REmap Analysis. International Renewable Energy Agency (IRENA), Abu Dhabi and ASEAN Centre for Energy (ACE), Jakarta

China cancels 104 coal projects

25 January 2017

Sian Crampsie

China's National Energy Administration has issued an order suspending the development of more than a hundred coal-fired projects.

The order will help China to meet targets it has set on installed coal-fired capacity as well as tackle air pollution and cut an excess of generating capacity. Around half of the capacity affected by the order was already under construction.

Altogether, the projects affected by the order amount to 120 GW, and are in addition to cancellations announced in 2016.

China stated in its 13th five-year plan (2016-2020) that it planned to cap installed coal capacity at 1100 GW by 2020. Its current installed coal-fired capacity is around 920 GW.

Some 54 GW of the capacity affected by the latest order is under construction and includes dozens of projects in the coal-rich northern and western regions of the country.

China is also grappling with an oversupply of capacity caused by reduced energy demand and an increase in electricity generation from renewables.

In October 2016 the Chinese government halted construction on over 30 large-scale coal-fired projects with a combined capacity of 17 GW.

Are ASEAN countries going the same way?
Who pays for the stranded investments later ?

⇒ASEAN is at a turning point and still can avoid the mistakes of others, but governments must decide now, which way they want to steer!

Source: http://www.modernpowersystems.com/news/newschina-cancels-104-coal-projects-5724078

Challenges in ASEAN for the Future of Power Markets

1. Many **Renewable Energy System Costs** are on same level as conventional power system costs!
2. **Imported LNG** becomes competitive ! ?
3. Long term **future price developments for oil** and imported coal are hardly predictable!
4. **PV power will be the cheapest** power source – It will challenge grids, utilities and conventional power producers !
5. **Consumer will become Prosumer** (producer and consumer) – They challenge distribution utilities!
6. **Transport and Power Sector** will merge within the next 15 years
7. **Climate Change commitments** will curtail conventional fuel supply

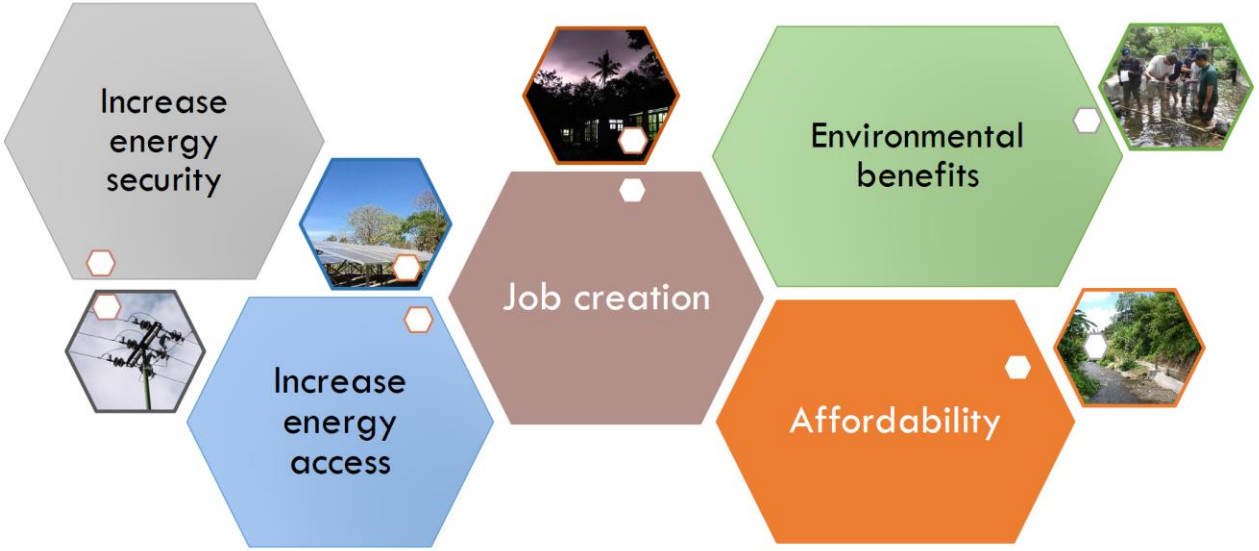
⇒ **Future of existing electricity market** need to adopt to challenges!

⇒ How can we get the required **flexibility into the energy market**?

⇒ How to **minimize macro economic costs of energy transition**?

Total Impact of RE development is much more than just kWh!

DRIVER FOR RENEWABLE ENERGY UTILIZATION



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Recommendations on energy research policy priorities based 1/2

1. Do not focus on hardware production, like PV modules and inverters
2. Maybe focus on battery development, if big resources and man power can be provided
3. Focus on Smart Grid topics
4. Focus on system integration, simulation, adaptation of PV/battery systems to Thailand situation
5. Focus on Battery, PV and EV system optimisation and adaptation
6. Focus on IT, services, and business model development
7. Focus on manufacturing BoS equipment, that has multiple applications

Recommendations on energy research policy priorities based 2/2

8. Focus on energy market design and energy economics,
9. Focus on financing, and business model development
10. Focus on impact research of new energy world to transport sector, energy sector
11. Focus on environment and social and economic impact of disruptive technologies
12. Build up “Power houses in Energy research, like an NREL or ISE or ISI Fraunhofer, that can do international recognised applied research in battery systems, in smart grid, in PV integration systems
13. Pick suitable research topics, that are revevant to Thailand, like Agro PV or Smart Grid

Land Use Issues for PV? The solution… Combining of Agriculture and 194 kWp PV

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Source: Projekt »APV-Resola; ISE Fraunhofer 2016

Combining of Agriculture and PV

Source: Projekt »APV-Resola; ISE Fraunhofer 2016

Several German ministries and firms address these challenges by various smart grid **pilot projects**

Pilot project activities

- Developing & testing hard- & software for smart grid
- Gaining know-how on interoperability, safety & usability
- Testing business models & processes
- Highlighting needs for changes in legal framework
- Improving consumer awareness & acceptance

Source: E-Energy, Siemens

Conclusions

- **Energy landscape is changing rapidly!**
- **Due to falling PV, Wind and storage costs and due to ICT technologies!**
- **This will challenge power/energy markets within the next decade worldwide including ASEAN countries/Thailand**
- **New strategies are needed by all energy market participants to stay ahead and stay alive!**
- **New business models have to be developed and offer opportunities for new market participants**
- **Policies and regulation need to be adopted to allow level playing field and foster new developments.**
- **Focus on relevant research areas and build up „power houses in research“ is important to stay in touch with new energy world**

Thank you for your kind attention!

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