Energy Crisis and Opportunities for Innovation

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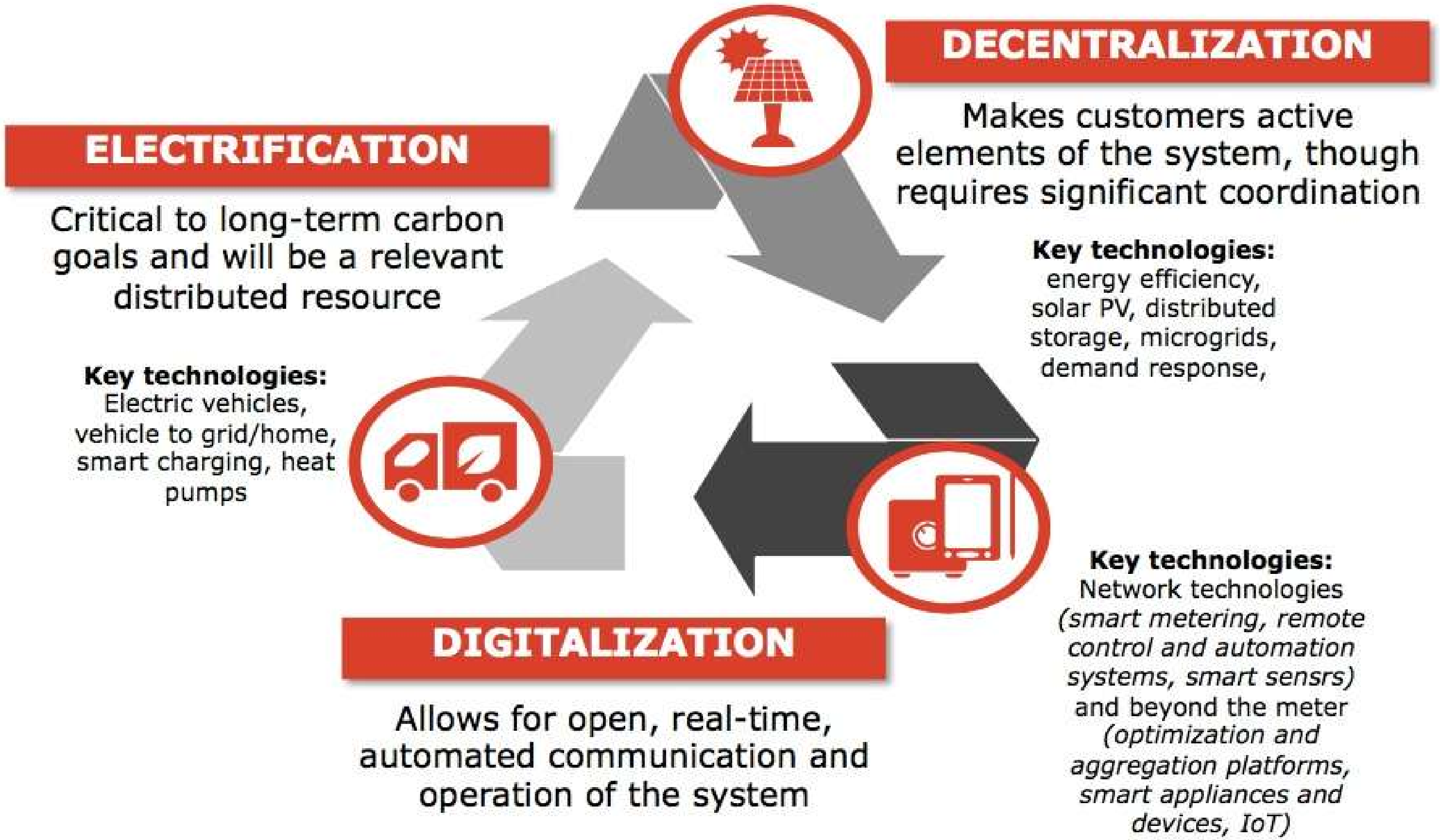
Agenda

- {Problem + Opportunity} 1: Stressed Power Systems + VPP + Smart Energy Cities
- {Problem + Opportunity} 2: Systemic supply risk + Diversification via renewables

{Problem + Opportunity} 1:
Stressed Power Systems + VPP + Smart Energy Cities

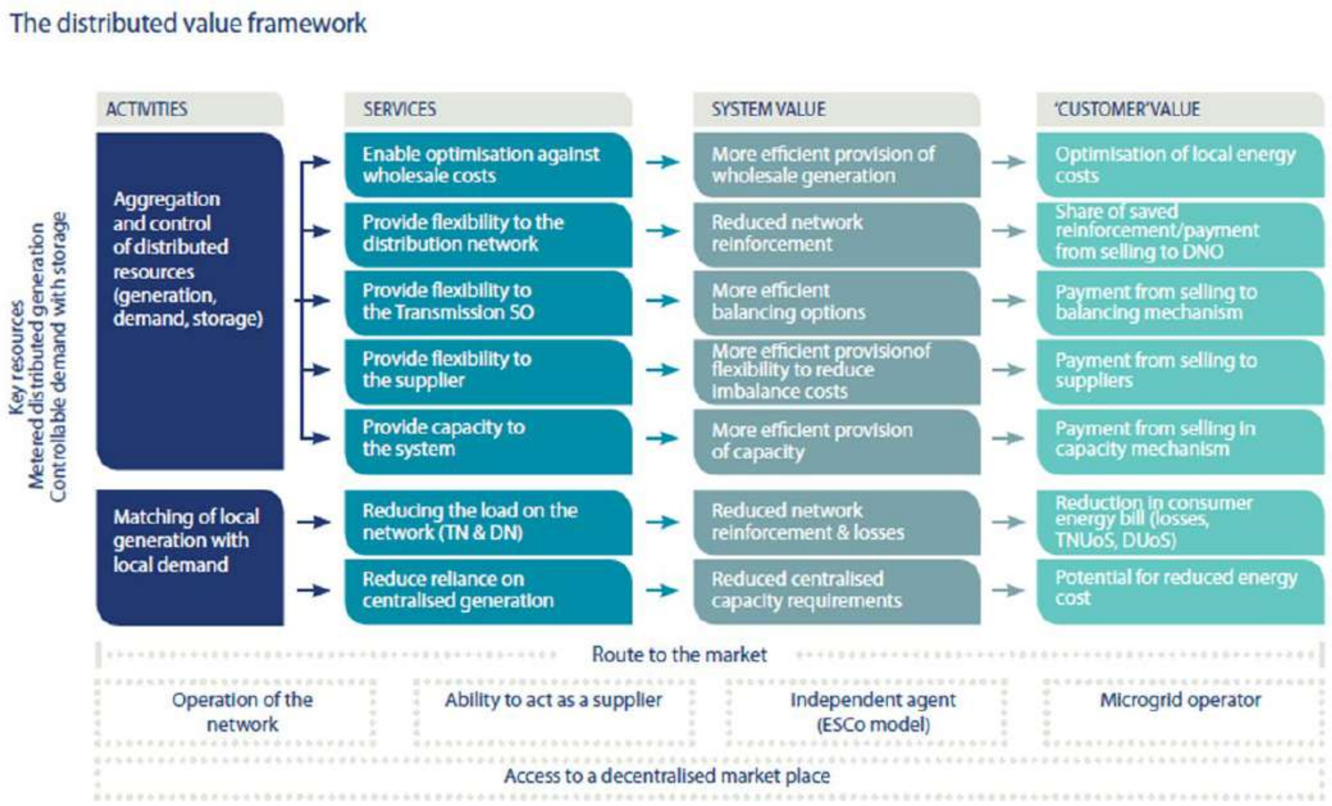
Context

Three trends of the grid edge transformation



Justification

- DER have been promoted mostly to provide the services of the 5 first entries, column 2
- In the short-term, DER may have a high(er) value in stressed power, as it is the case of Colombia (2 last entries, column 2)



Source: Exelon (2018)

The Shadow Price of DER in Stressed Power Systems

First set of constraints (T and D)

- Centralized power systems face expansion difficulties due to rising environmental constraints and social resistance
- Critical for T and D near/within large urban settlements

Second set of constraints (G)

- Climate change is increasing the kurtosis of the probability density function of inflow water to hydroelectric plants
- Absence of a portfolio approach to expand primary energy sources; focus on large-scale RES

Colombian Power System Constraints

- First network constraint: long environmental licensing time (24 months, nominally) in T projects
- Second network constraint: poor communities in remote areas make disproportionate compensation requests to T builders; NIMBY-owners of suburban land veto environmental licensing of substation (T and D) expansion

Only 85% of scheduled investments in T and oil/gas pipelines get finished per year (Fedesarrollo 2018). Cumulative underinvestment

Colombian Power System Constraints

- First generation constraint: El Niño phenomenon hits Colombia every 3-5 years; longer extremely dry periods + small reservoir storage capacity (stored water lasts less than 3-4 months with 0 inflow if highly dispatched)
- Second generation constraint: sudden stop of gas promoted without regard to security of supply; delayed entry of hydro for technical reasons and RE plants due to community opposition

Simplistic energy transition policy that does not consider the social context and the cost of supply portfolio adjustment

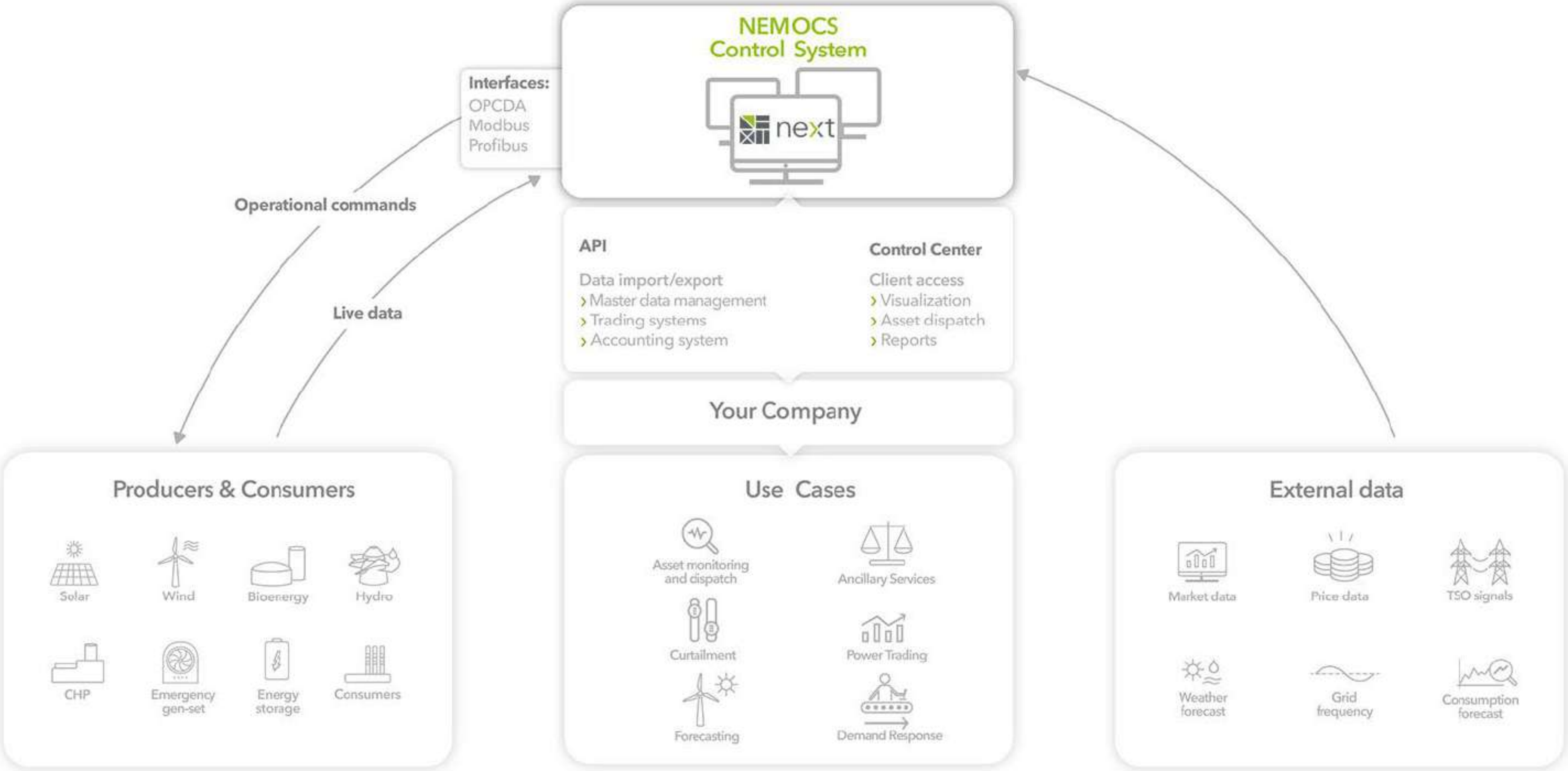
VPP to Increase System Resilience

- PPP model to accommodate the ´public good´ nature of resilience
- VPP aggregates dispatchable assets and solely sells ´resilience flows´ to XM (system operator, publicly owned)
- PPA with a take-it-or leave it price offer for VPP with a minimum output (~ 100 GWh/y per aggregator)
- Government may translate PPA costs to financially illiquid D firms at a discount

Incentive structure for the Aggregator:

- 10-year *Flex*-PPA contract + shadow pricing of resilience flows by zone (a limited number of zones)

Virtual Power Plant-as-a-Service

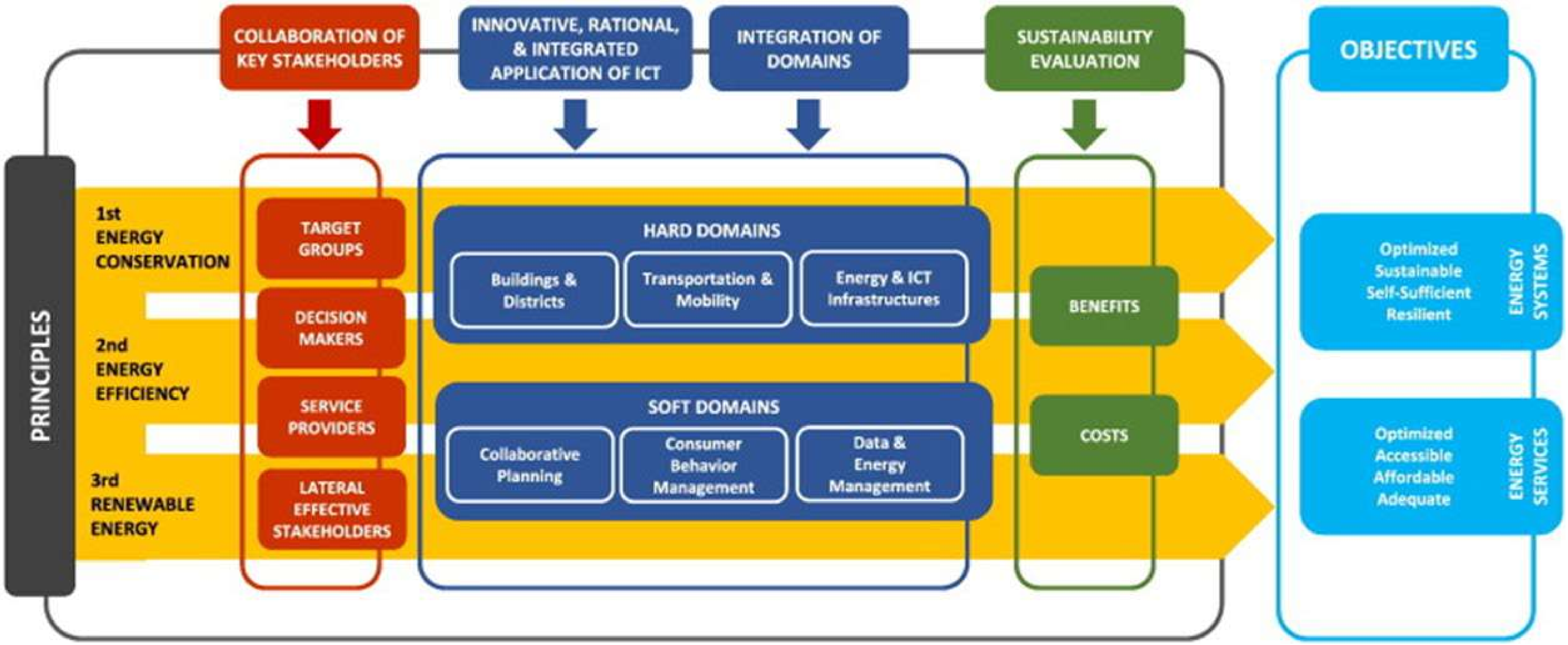


Smart Energy Cities

- Digitally supported platforms and ecosystems can put together devices, people, firms, money and new services in the urban milieu
- Allow big data and machine learning algorithms provide useful, real-time information for problem identification and management
- Customers may become electricity ´citizen-regulators´ and/or ´citizen-entrepreneurs´

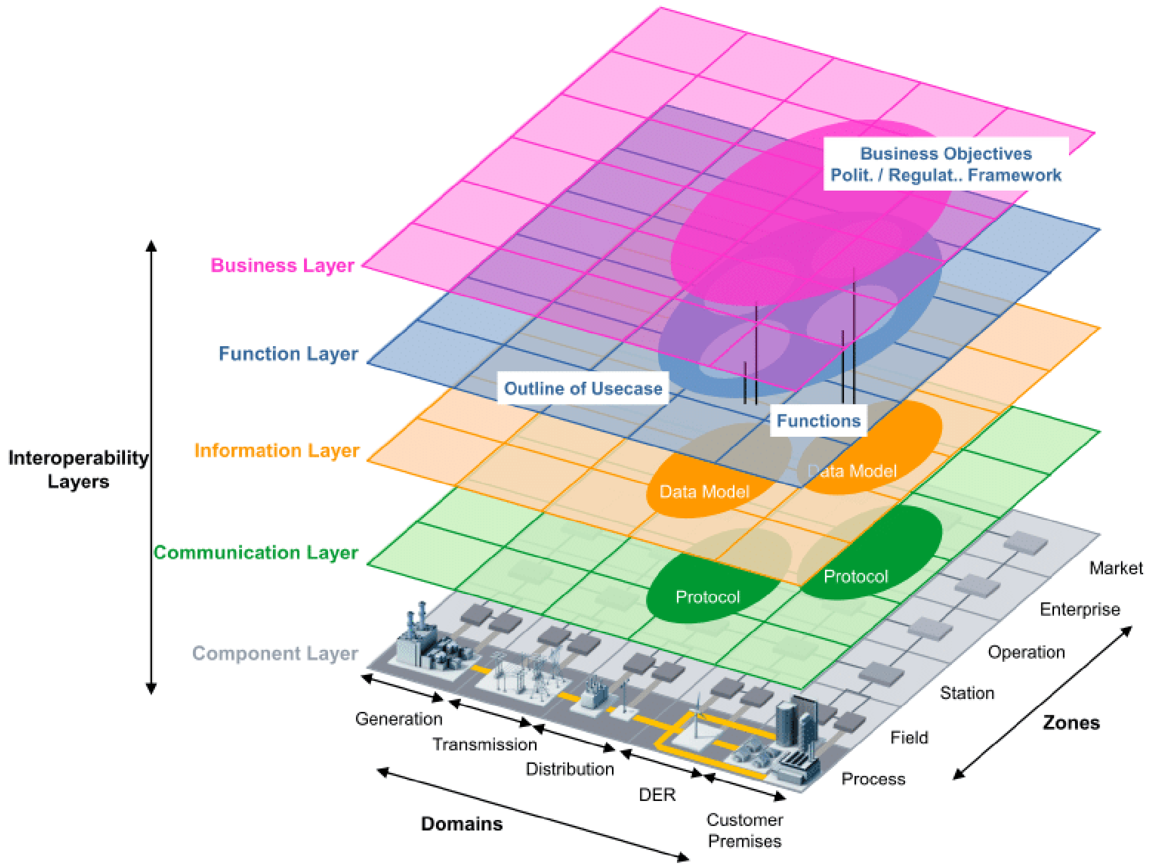
Smart Energy Cities

Step 1: promote Smart Energy Cities in large agglomerations



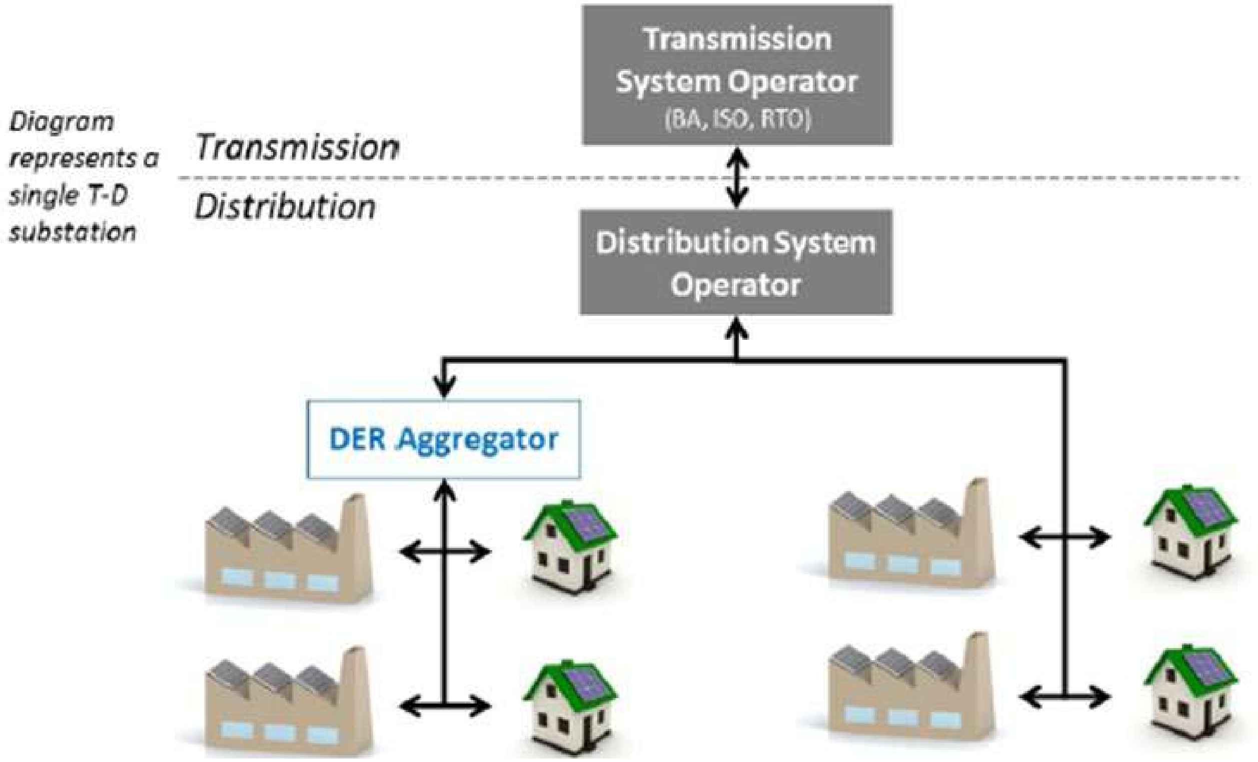
Smart Energy Cities

Step 2: Smart Grid 2.0 in large D utilities



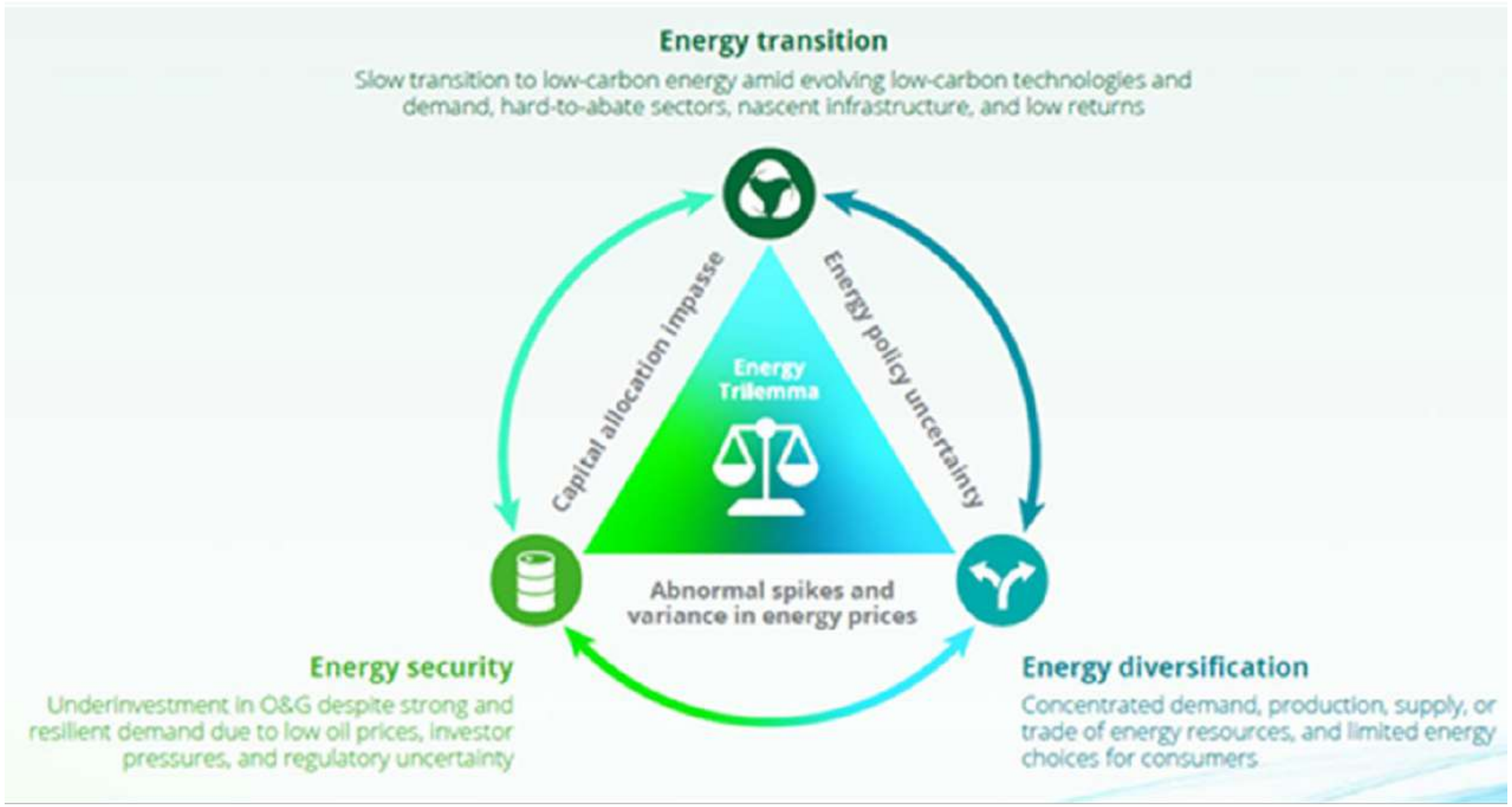
Smart Energy Cities

Step 3: switch to a DSO architecture *if* DER density increases



{Problem + Opportunity} 2:
Systemic supply risk + Diversification via Renewables

The energy trilemma since 2022



Key renewable risks

- Demand. Fluctuations in energy demand can impact the revenue generated from renewable energy projects
- Technology change. Rapid advancements in technology can lead to obsolescence of current renewable energy technologies
- Regulation. Changes in government policies, regulations, and subsidies can affect the profitability of renewable energy projects
- Incumbent dominance in renewable entry. Corporate cross-subsidization may deter entry of new investors
- Community opposition. Variate and increasing requirements of communities impede timely project completion

Risk reducing instruments

- Hedging instruments. A secondary market for contracts is indispensable to hedge against spot market volatility
- Insurance products. Weather risk insurance can protect against revenue losses due to unfavorable weather conditions
- Government guarantees. Governments can provide guarantees or incentives to reduce regulatory and technology risks for new investors
- Adaptive management of communities. Introduce variable community development programs based on their support to ESG outperforming renewable projects