



DISTRICT ENERGY
IN CITIES
INITIATIVE

E-TRAINING PROGRAM DISTRICT ENERGY DEVELOPMENT



MODULE 6. BUSINESS MODELS, FINANCING OPTIONS AND PROCUREMENT OF SOUND SUSTAINABLE DISTRICT ENERGY SYSTEMS





LEARNING OUTCOMES

Objective: share insights on business models, financing options and procurement of sound sustainable district energy systems

By the end of this module, you will be able to:



Describe, understand and discuss the importance of developing business models for sound & sustainable DES



Recognise and apply the key steps in developing business models for sustainable DES



Define key actions from local authorities to ensure this



List the strengths and limitations of each of the business models

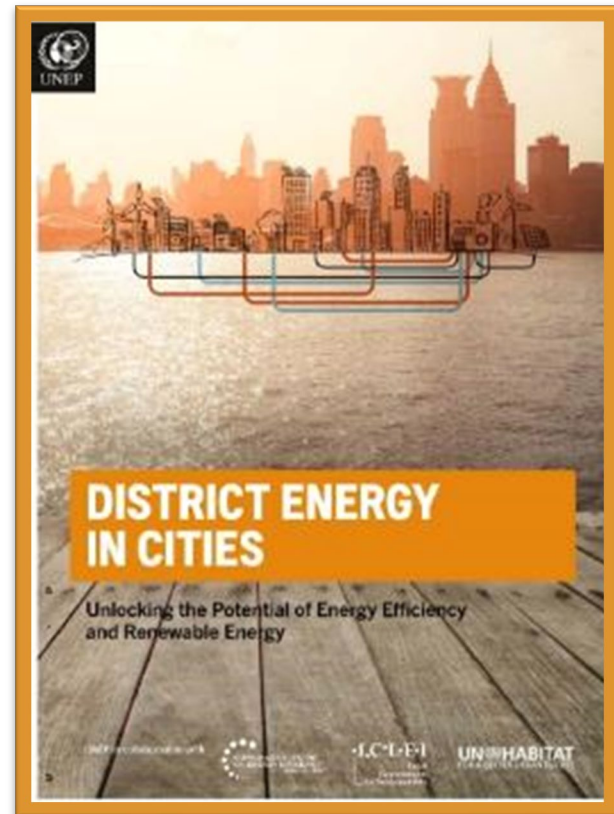


MODULE 6. BUSINESS MODELS, FINANCE & PROCUREMENT

ROLE OF BUSINESS MODELS

Key Steps in District Energy planning

1. **Assess** existing energy and climate policy objectives, strategies and targets and identify catalysts
2. **Strengthen** or develop the institutional multi-stakeholder coordination framework
3. **Integrate** district energy into national and/or local energy strategy and planning
4. **Map** local energy demand and evaluate local energy resources
5. Determine relevant **policy design** considerations
6. Carry out **project pre-feasibility** and viability
7. Develop **business plan**
8. Analyse **procurement options**
9. Facilitate **finance**
10. **Replicate**

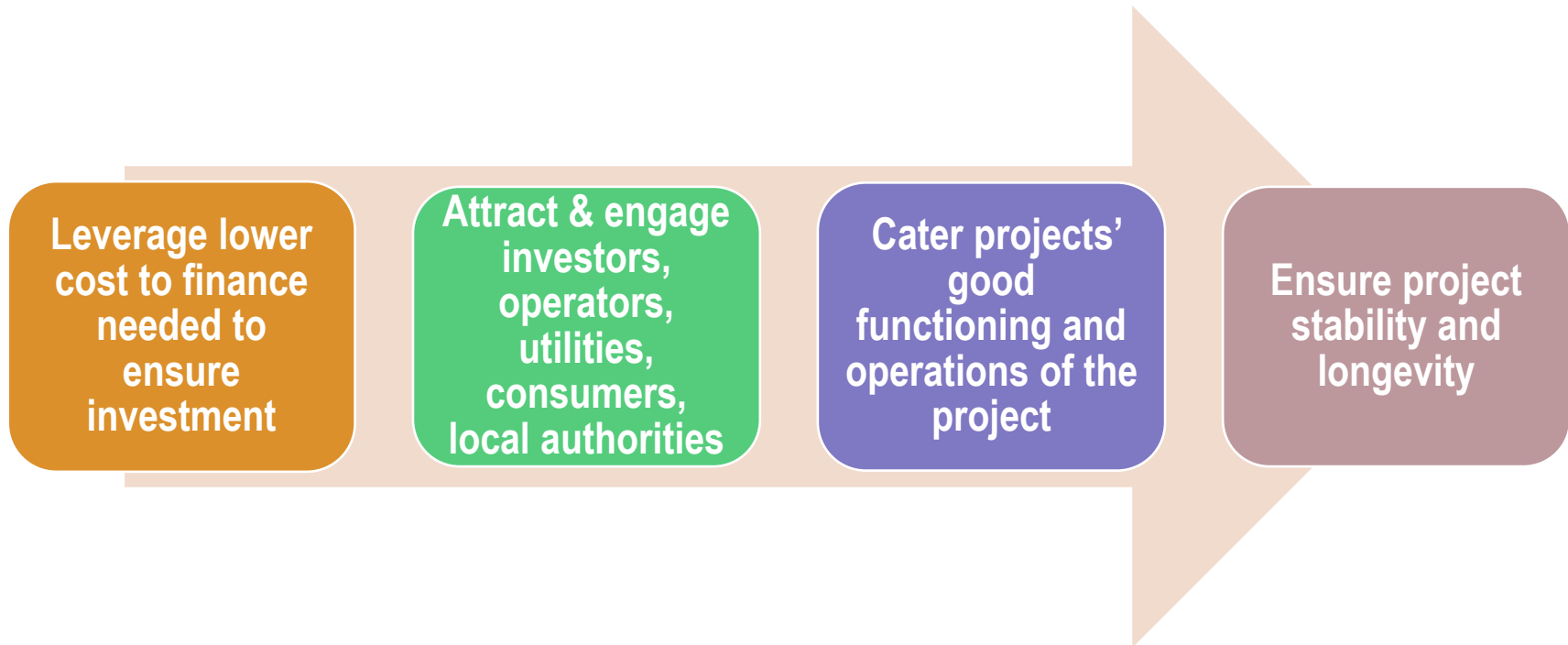


Source: District Energy in Cities. Unlocking the Potential of Energy Efficiency and Renewable Energy



ROLE OF BUSINESS MODELS

The role of a solid business model in District Energy projects



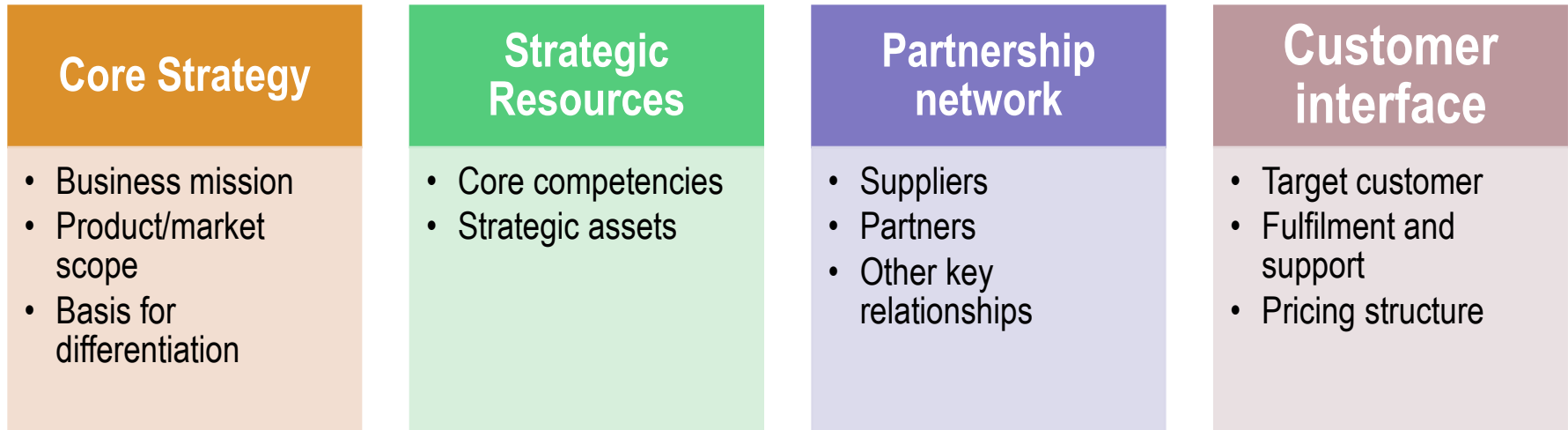
“A mediocre technology pursued within a great business model may be more valuable than a great technology exploited via a mediocre business model”
Chesbrough, 2009



DEFINITION

A business model is defined as ...

The main components of a business model are

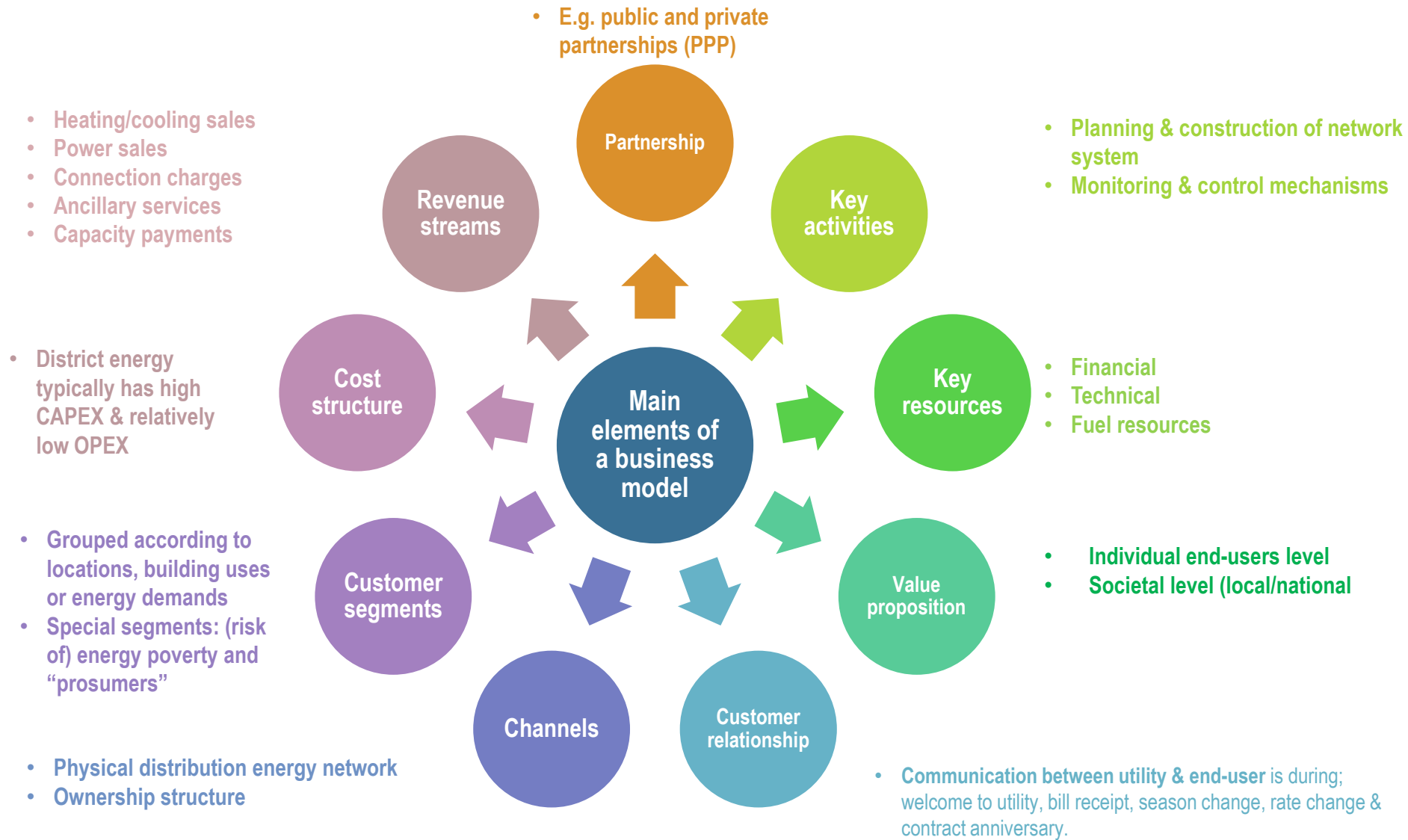


“A plan for the successful operation of a business, identifying sources of revenue, the intended customer base, products, and details of financing”

Harvard business review, 1998.

MODULE 6. BUSINESS MODELS, FINANCE & PROCUREMENT

CHARACTERIZATION OF BUSINESS MODELS





MODULE 6. BUSINESS MODELS, FINANCE & PROCUREMENT

CHARACTERIZATION OF BUSINESS MODELS

Business models in DES based on ownership type

Fully public models	PPP/hybrid models	Privately owned models
<ul style="list-style-type: none">• High degree of control• Potentially high degree of coverage• Medium/low returns• High public risk	<ul style="list-style-type: none">• Medium degree of control• Coverage based on negotiations• Medium/high returns• Medium public risk	<ul style="list-style-type: none">• Low degree of control• High returns• Medium/low public risk

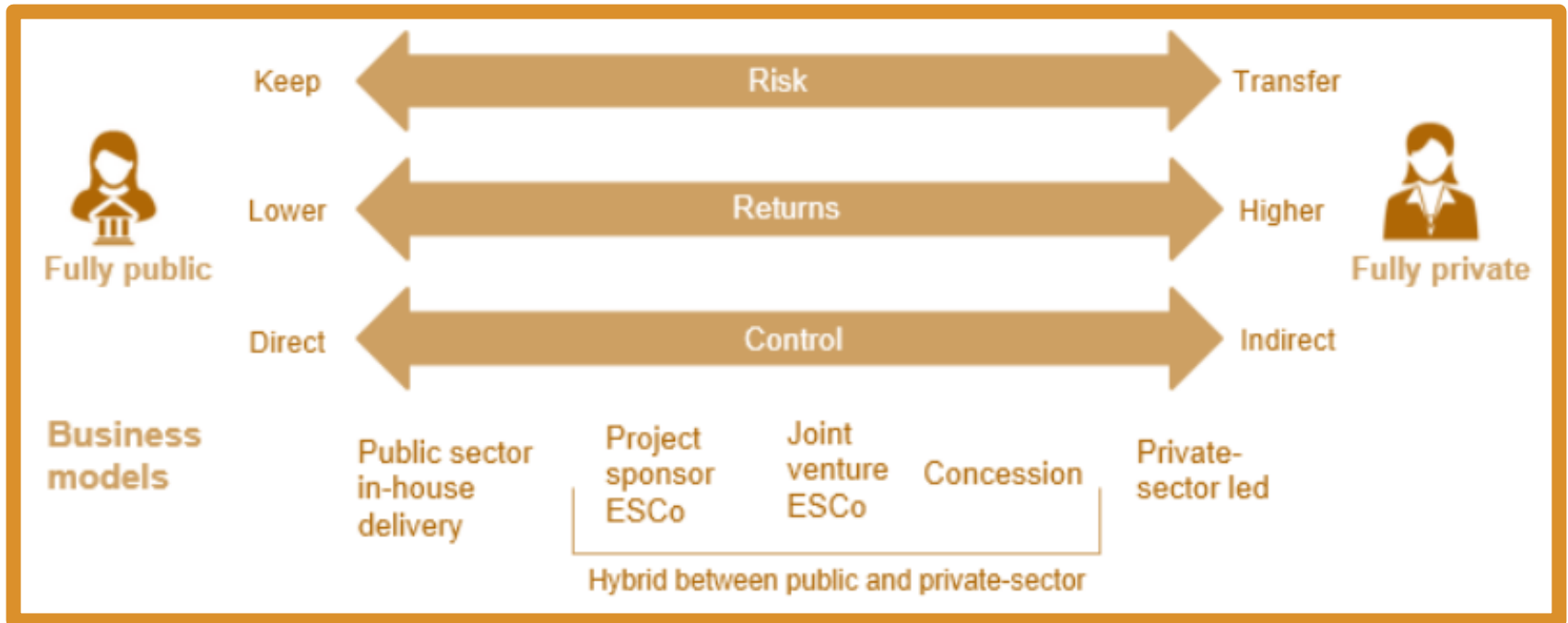
Source: District Energy in Cities. Unlocking the potential of Energy Efficiency and Renewables



MODULE 6. BUSINESS MODELS, FINANCE & PROCUREMENT

CHARACTERIZATION OF BUSINESS MODELS

Business model, based on degree of control, return and risk



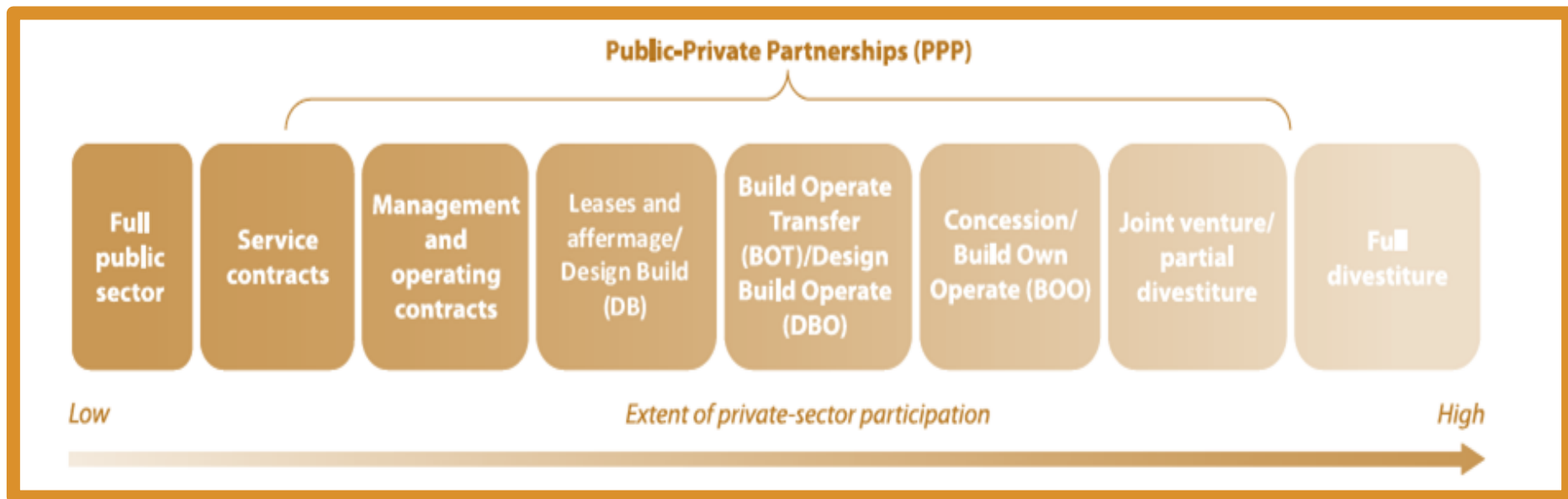
Source: Bloomberg New Energy Finance



MODULE 6. BUSINESS MODELS, FINANCE & PROCUREMENT

CHARACTERIZATION OF BUSINESS MODELS

Private sector participation in PPPs

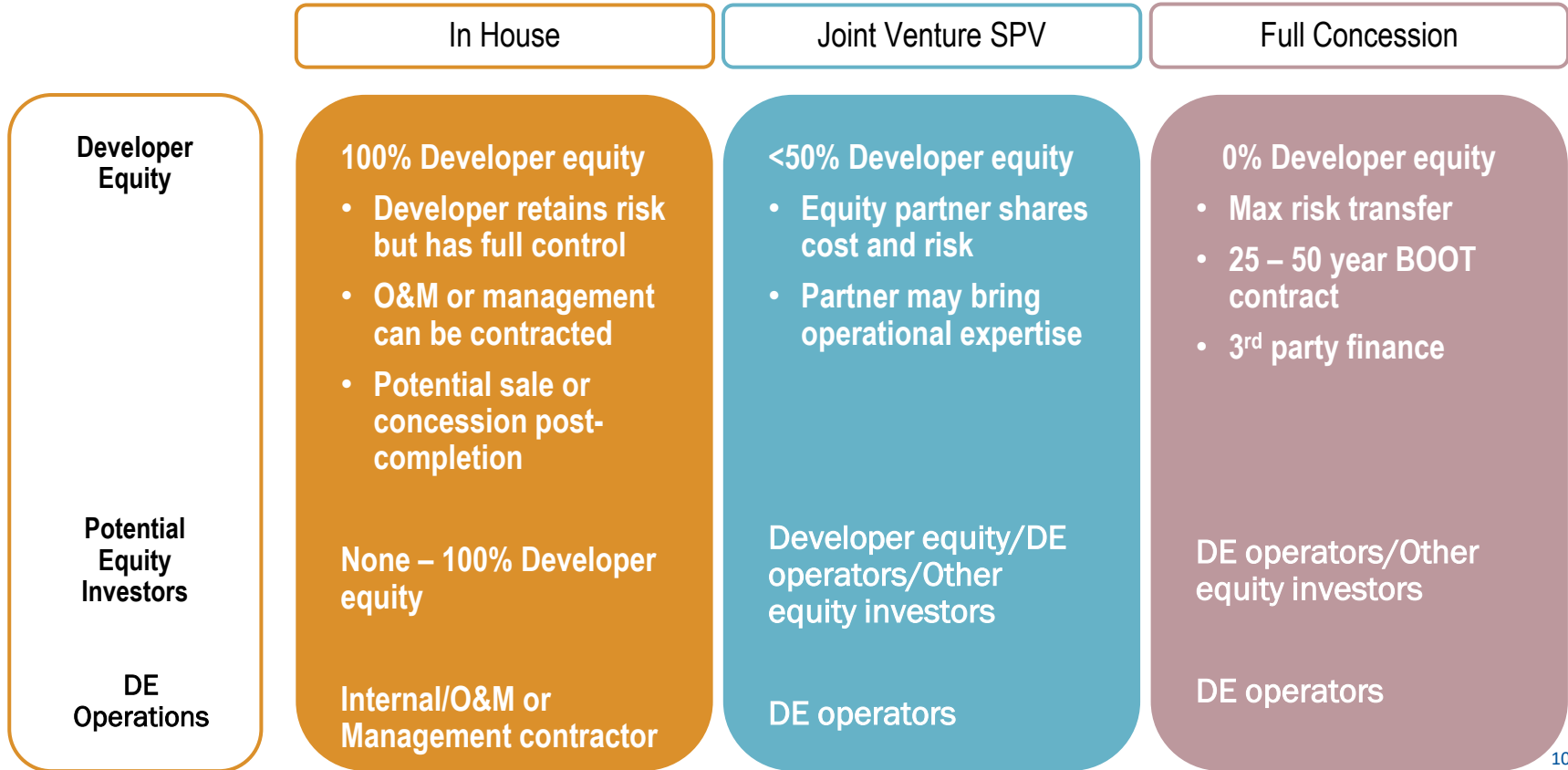


Source: Ang and Marchal, 2019

MODULE 6. BUSINESS MODELS, FINANCE & PROCUREMENT

CHARACTERIZATION OF BUSINESS MODELS

DE business models for real estate developers



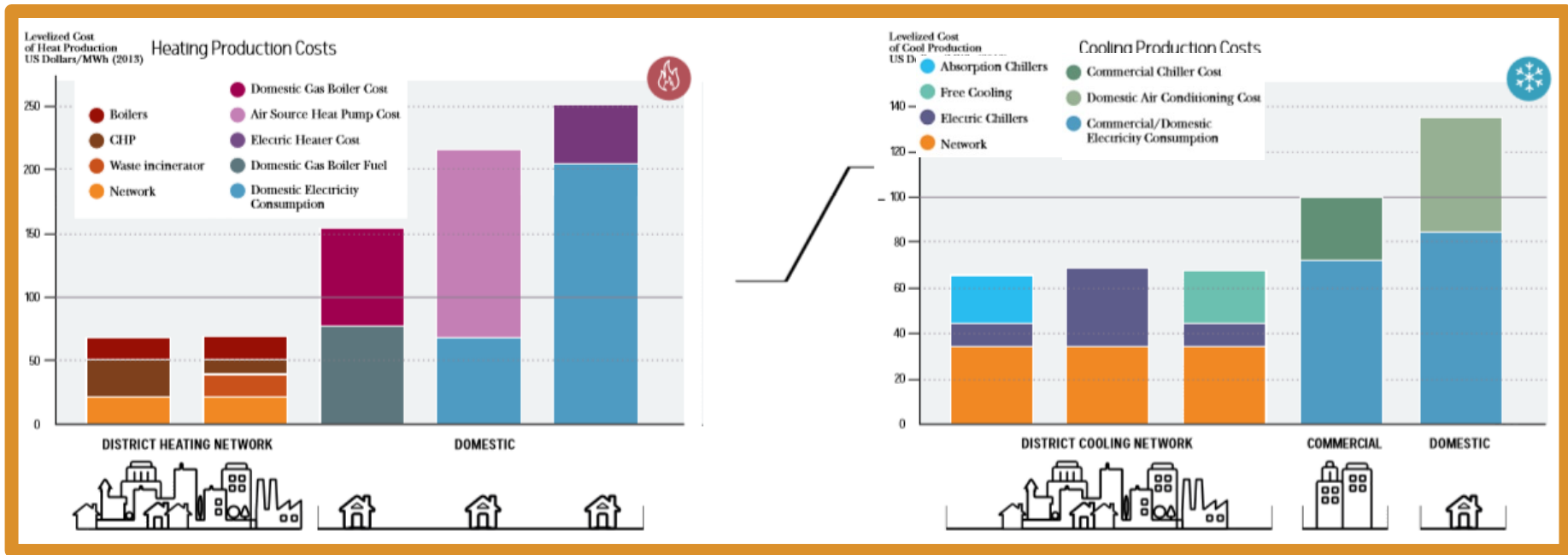
Source: : King and Spalding for District Energy in Cities Initiative

MODULE 6. BUSINESS MODELS, FINANCE & PROCUREMENT

COSTING

How much does District Energy cost?

Due to its ability to use waste heat, higher efficiency cooling and thermal storage along with avoiding individual energy solutions and their maintenance and over-capacity district energy can be delivered **far cheaper** than conventional heating/cooling systems, with much **lower carbon emissions and fossil fuel consumption in energy dense areas.**



Source: District Energy in Cities. Unlocking the Potential of Energy Efficiency and Renewable Energy

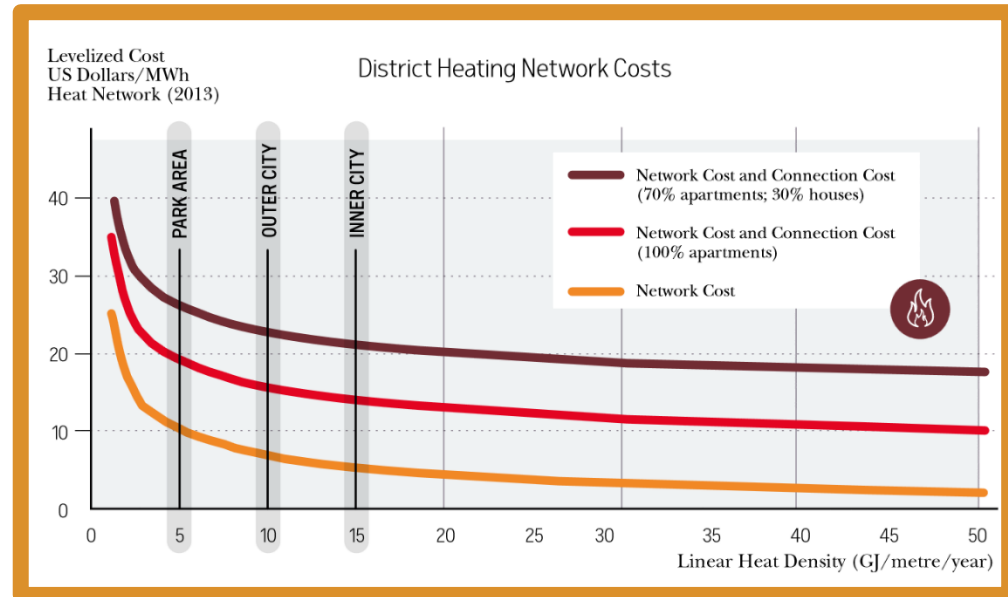


COSTING

How much does District Energy cost? - Importance of load density

Load density is crucial to reducing the cost of the heat or cool network. Cities should ensure that the majority of appropriate demand is connected to the DES through land-use policies, subsidies and advocacy.

- **'New' cities** beginning to develop DE should focus on 'priority zones' with high load density to prove the technology.
- **'Expanding' cities** should be designing their city to have a higher load density and more mixed use zoning to optimise investments.
- **'Consolidated' cities** may have paid off a lot of CAPEX and can start connecting less dense neighbourhoods and interconnecting systems.
- **'Refurbishment' cities** should focus on maintaining high customer connection.



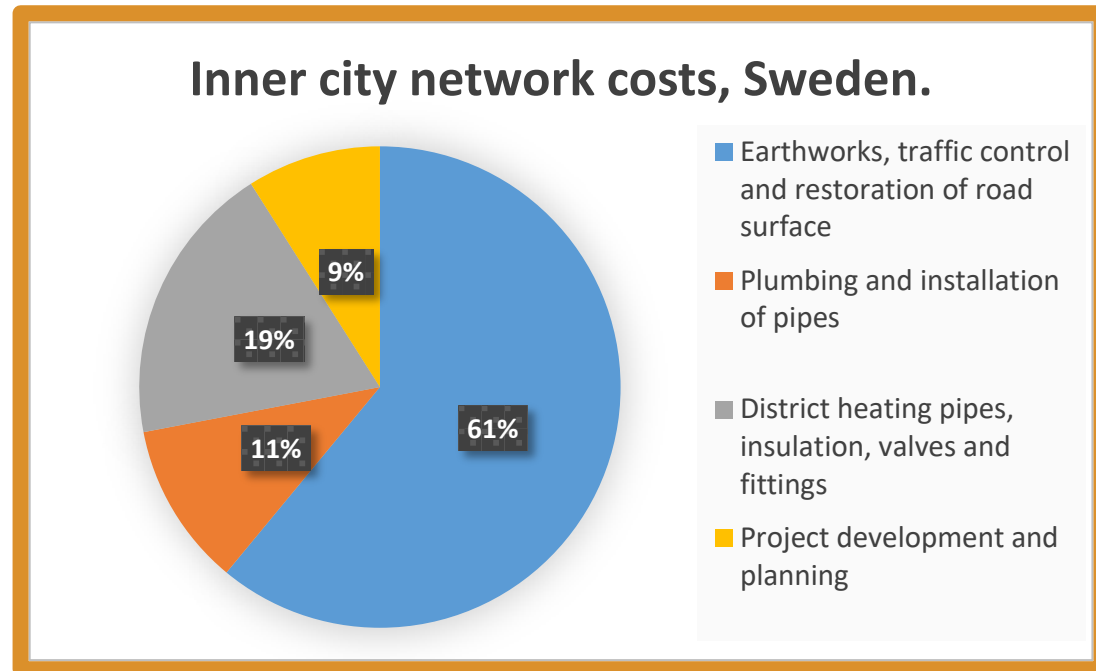
Source: District Energy in Cities. Unlocking the Potential of Energy Efficiency and Renewable Energy



COSTING

How much does District Energy cost? - Coordination and capacity

- **Strong coordination between different city functions** within a 'multi-stakeholder coordination framework' is vital to reducing costs.
- Capacity within local stakeholders for assisting projects through planning process **reduces the planning and development costs (~20% of investment)**.
- **Huge potential for sharing cost of earthworks with other utilities, transport/area development & road surfacing works which dramatically reduces cost.**
- The **influence of earthworks on the cost (61%)** in inner city is a major reason why the cost of DHN can vary so much between cities.

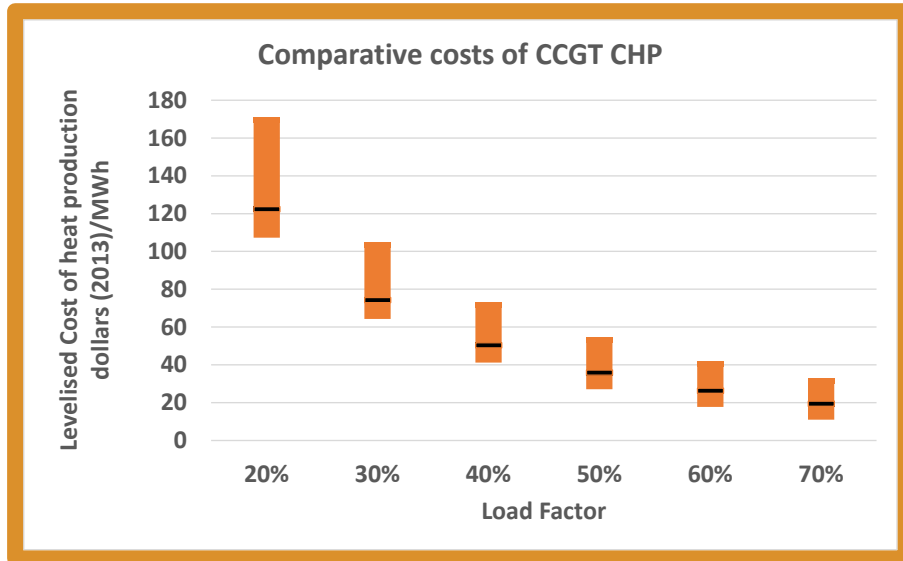
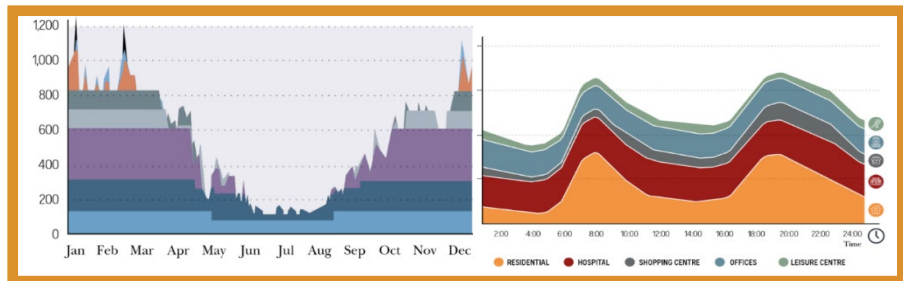


MODULE 6. BUSINESS MODELS, FINANCE & PROCUREMENT

COSTING

How much does District Energy cost? – Anchor loads and storage

- Having a heat or cool profile that is very seasonal will mean low utilization for heat capacities, such as CHP, meaning higher costs. Connecting **anchor loads** such as swimming pools can ensure higher utilization outside the traditional heating/cooling season.
- A heat or cool profile which fluctuates from low to high across an average day can mean low utilization and higher costs. **Storage of heat or cool** can avoid this and for DC, can avoid electricity demand during peak periods. **Anchor loads** also reduce the range between daily low & high demand.



Source: District Energy in Cities. Unlocking the Potential of Energy Efficiency and Renewable Energy

Note: CHP heat tariff in graph calculated from required return after electricity revenue

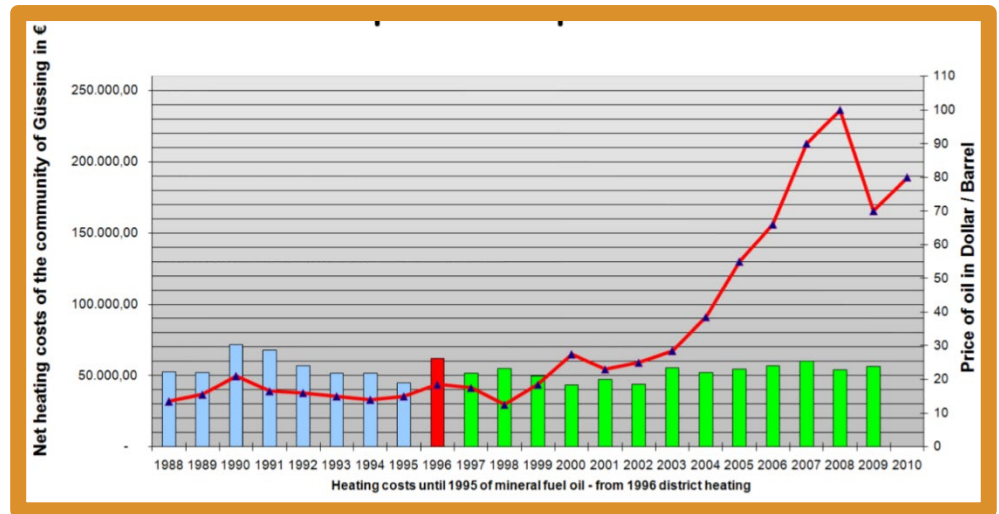


COSTING

How much does it cost? - Disconnection from fossil fuel prices

- **Higher efficiency, use of waste heat and renewables** means DE uses less fossil fuels and is thus **more resilient to fossil fuel price increases** and will enable a **steadier price for heat or cool**.
- However, decreases in fossil fuel prices may make alternative technologies seem cheaper, especially in the absence of a strong carbon price or mechanism for levelling the playing field.

Güssing's district heat price managed to disconnect from the oil price as the city became more energy independent



Fossil fuel price projections will be accounted for in the feasibility study of the project.

'New' cities may use gas, coal or electricity which can initially compete with conventional technologies and may reduce short term risk.

Source: Solutions gateway Starting district heating in existing cities and developments

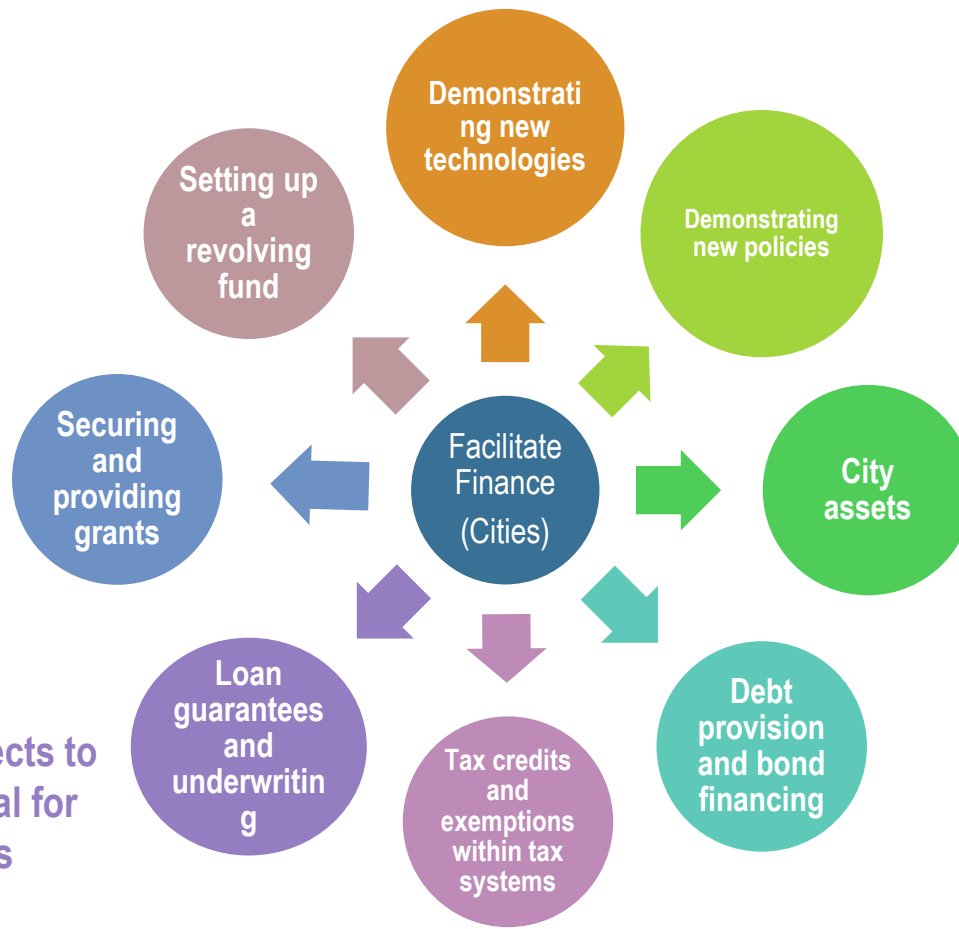


FINANCIAL INSTRUMENTS

'New' cities can set up a revolving fund to create multiple starter networks

Cities can provide grants to projects and/or attract national/international grants

City's can guarantee projects to lower the cost of debt; vital for socially important projects



Demonstration of policies can leverage private sector investment in other networks

City assets like land, public-rights-of-way & access to publicly owned anchor loads, reduce risk of projects

Many cities use their access to cheaper debt to lower the financial cost of a project

MODULE 6. BUSINESS MODELS, FINANCE & PROCUREMENT

FINANCIAL INSTRUMENTS

Investor understanding of investments per project phase

Project phase	Risk exposure	Financial instrument	Possible financing body
1. Feasibility	Demand Permits Competition Credit Price External impacts...	Grant	National or international funding
2. Development	Same as above	Grant or Project Owner	Same as above or project owner funds
3. Construction	Construction, fixed asset	Loan	Infrastructure fund
4. Operation	Operational, Market	Loan	Pension fund, Insurance, Infrastructure fund
5. Reinvestment	Market	Corporate funding	Owner (municipality/ city/ private company)

Source: DHC Think tank to Unlock Investments in DH



MODULE 6. BUSINESS MODELS, FINANCE & PROCUREMENT

INSTRUMENT #1

Demonstration Projects

“By demonstrating new technologies, new policies and demonstrating institutional capacity, cities lower the perceived risks to private investors, local governments and other funding sources and prove the commercial viability of district energy”. **District Energy in Cities Initiative, UNEP, 2014**

CASE STUDY: Vancouver

- City owned demonstration project: Southeast False Creek Neighbourhood Energy Utility (SEFC NEU).
- City-owned greenfield district heating network using waste heat from sewage.
- Financially structured like a private sector project to prove commercial viability.
- Demonstrated new connection policies in the city.
- Has led to one new district heating system and the switching of two other systems from gas to renewables.



Source: Sauder, Integrated community Energy system Business Case Study

MODULE 6. BUSINESS MODELS, FINANCE & PROCUREMENT

GREEN BONDS

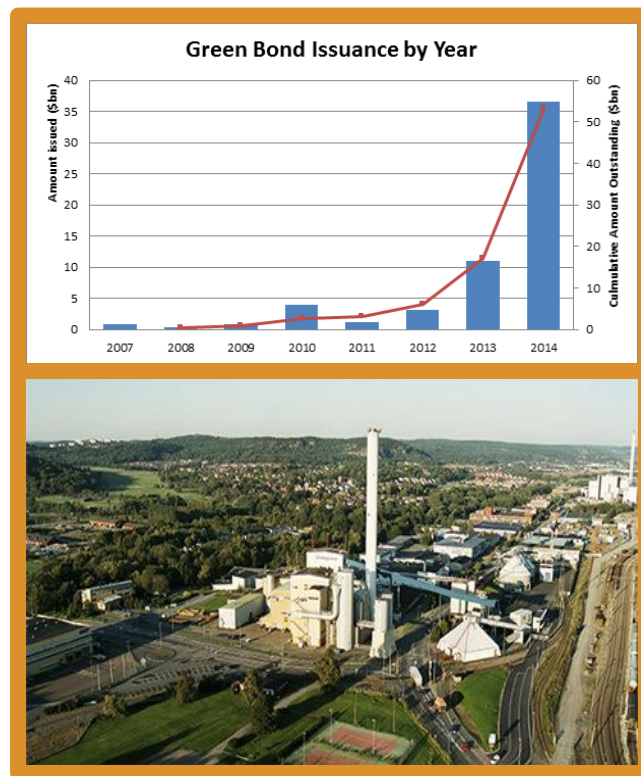
Definition

“Green bond is a debt security that is issued to raise capital specifically to support climate related or environmental projects”. **World Bank, 2014**

CASE STUDY: Gothenburg, Sweden

- City council adopted 12 local environmental quality objectives with associated intermediate objectives
- Green projects form a portfolio of assets eligible for financing and refinancing by green bonds (e.g. RE, EE, clean transport, green buildings...)
- The green bond supports the decarbonisation of the DH by 2030: 0.065 kgCO₂/kWh (2018)

... Other examples are Johannesburg and Paris



Source: climatebonds.net, GreenGothenburg.se



MODULE 6. BUSINESS MODELS, FINANCE & PROCUREMENT

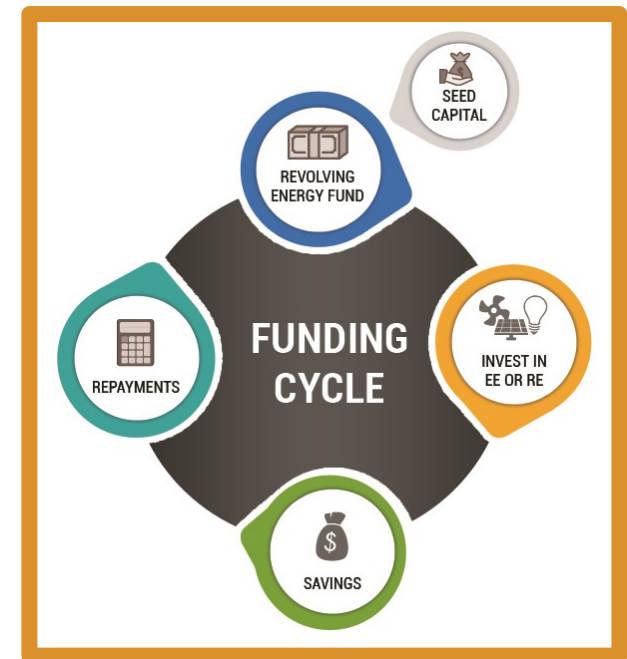
REVOLVING FUNDS

Definition

“Revolving fund is an amount of money that exists in order to finance something, but from which any loans must be replaced in order that the full amount is available again”. **Cambridge Dictionary**

CASE STUDY: Toronto Atmospheric Fund (TAF)

- Set in 1991 with US\$20.2 million from selling a city-owned building
- Promotes testing and scaling up of solutions in renewable energy, energy efficiency and reduced fossil fuel consumption
- Re-invest profits into new projects
- Supported the implementation of a tri-generation system financially and with know-how



Source: 100% Renewables



MODULE 6. BUSINESS MODELS, FINANCE & PROCUREMENT

CITY LEVEL SUBSIDY

Definition

“A subsidy is a form of financial aid or support extended to an economic sector (business or individual) generally with the aim of promoting economic and social policy ”. Meyers, N

CASE STUDY: Paris Urban Heating Company (CPCU)

- The municipality owns 33% share in the CPCU
- CPCU’s targets on heat production are:
 - 50% renewable or recovered heat in 2015
 - 60% by 2020
- If 50% target is met, a national incentives will reduce VAT on heat by 5.5% to costumers
- The concession contract sets a cap for the heat delivered against the share of renewables
- For those living in social housing, the city enforces a special law



Source: District Energy in Cities, unlocking the potential of Energy Efficiency and Renewables



LAND VALUE CAPTURE (LVC)

Definition

“Land Value Capture is a policy approach that enables communities to recover and reinvest land value increases that result from public investment and government actions”. OECD

Highlights

- **Applicable to new development areas** (e.g. around new train station) and new cities.
- In Latin America **transition of land from rural to urban** can **increase land value** by 400%.
- Capture land-owner windfalls from land value increase to finance new infrastructure investment.
- Typically used to finance the infrastructure (e.g. train or metro) that leads to the land-value increase but high potential to finance district heating infrastructure.
- Use **land-use policies** such as mixed use zoning and compact land use to design areas to be high potential for district heating.
- Finance district heating development using DB-LVC.
- China will be using DB-LVC for high-potential urban areas around new transit stations to finance infrastructure investment and district heating.



PROCUREMENT IN DES

- **Procurement options** will depend on the business plan and degree of private sector involvement.
- Designing a **procurement package** that will **attract strong bids from the private sector** can require experience in local authorities or municipal utilities and capacity building is key to ensuring procurement is high quality and competitive.
- **International and national support** in capacity building for cities, as well as city-twinning and inter-city support can ensure that cities have appropriate experience in designing procurement packages and contracts with the private sector.
- If district energy is to be developed under a concession contract the procurement package is an opportunity for the local authority to control and direct private sector investment.
- Many cities procure the private sector on short-term design and build contracts.
- DES tend to be **natural monopolies**. **Requires price regulation** to ensure:
 - Undersupply; overprice
 - Normally, treat them as a public good
 - Re-structuring of city's urban plan



MODULE 6. BUSINESS MODELS, FINANCE & PROCUREMENT

REGULATORY INSTRUMENTS

Price regulation models

True cost pricing

- **Benefits:** works well when interests are aligned in keeping prices down
- **Challenges:** it does not control increasing spending in for example operation and maintenance, increasing depreciation time, or increasing salaries.

Price cap

- **Benefits:** ensures prices remain below the political set threshold
- **Challenges:** fairly rigid model that often does not include room for local conditions

No price regulation

- **Benefits:** a simple method that does not require detailed regulation and can potentially realise efficient prices if proper (competition) mechanisms are in place
- **Challenges:** it does not sufficiently account for sunk-costs made by customers who connect to district heating system

DES tend to be **natural monopolies**. This requires **price regulation** to ensure undersupply; overprice



MODULE 6. BUSINESS MODELS, FINANCE & PROCUREMENT

REGULATORY INSTRUMENTS

District Heating Regulation



Company



Customer



State

- No 'one size fits all' regulatory model for the sector
- Models range from heavy regulation (overly bureaucratic and prescriptive) to a 'light touch' approach with no price regulation
 - Impact on likelihood of private sector participation
- **National Governments** may enact an overarching national law which governs the sector, or it may be covered by wider energy sector legislation
- **Regulation** may also be necessary to ensure that the sector contributes to national objectives for renewable energy or CO2 reductions
 - Alternatively, this can be accomplished indirectly through carbon pricing or taxation of fossil fuels
- Correct balance that **protects consumer rights**, enables utility operators to cover costs, make a reasonable profit and **incentivise investment in the sector** (especially needed for decarbonisation)



MODULE 6. BUSINESS MODELS, FINANCE & PROCUREMENT

REGULATORY INSTRUMENTS

Consumer protection policies: The case of Singapore

- High opportunity district cooling zone identified.
- 2011 District Cooling Act mandates connection which ensures business model is sustainable
- Tariff regulations ensure consumers protected from high prices
- Future financial gain shared with customers



Source: District Energy in Cities. Unlocking the Potential of Energy Efficiency and Renewable Energy



DISTRICT
ENERGY
IN CITIES

CASE STUDIES



Yerevan, Armenia Source: Unsplash

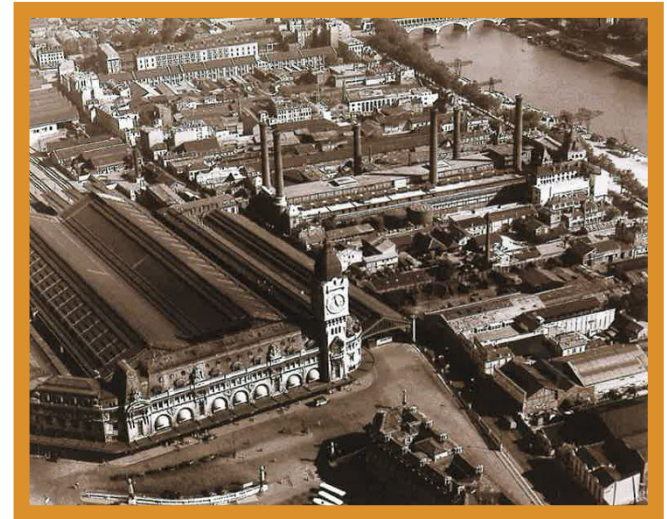


MODULE 6. BUSINESS MODELS, FINANCE & PROCUREMENT

CASE STUDY: PARIS, FRANCE

90 years of concession

- Consumption of coal in the centre of Paris was a significant problem (air pollution, deliveries and fire risk)
- Operates concessions for many utilities
- 1927: Private concession developed for district heating.
- 1949: City of Paris becomes 33% shareholder in CPCU



Source: CPCU

Today district heating is nearly **50% renewable** and supplies equivalent of 500,000 households including 100% of hospitals, **50% of social housings**, and 50% of public buildings.

CASE STUDY: PARIS, FRANCE

Ownership structure & control

- City of Paris owns the network.
- Production facilities mostly owned by CPCU except 3 waste-to-energy plants.
- CPCU does all maintenance, investment and customer interactions.
- 4 of 10 directors on CPCU's Board of Directors nominated by City of Paris.
- Concession contract specifies maximum heat tariff indexed by percentage of renewable energy sources used to encourage renewables.
- City of Paris can control the production mix of heat and target higher renewable shares.

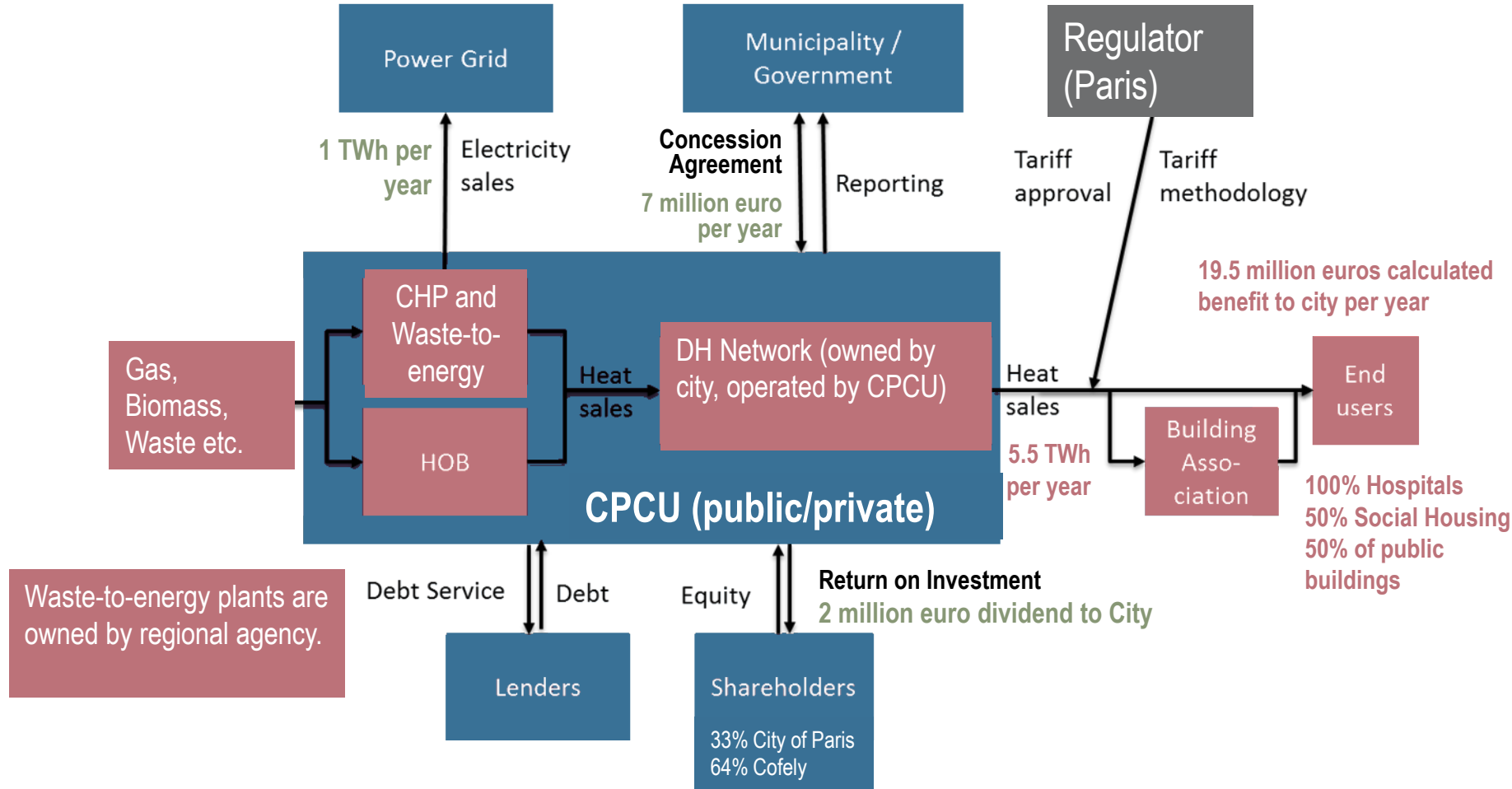


Source: Natura Science

MODULE 6. BUSINESS MODELS, FINANCE & PROCUREMENT

CASE STUDY: PARIS, FRANCE

Split asset concession model: Public/Private Concessionaire





CASE STUDY: PARIS, FRANCE

The role of local government

PLANNER AND REGULATOR

- Urban Development Zones
- Will develop mandatory connection once more than 50% renewable (2015)
- Strategy and targets: 60% renewable by 2020.

FACILITATOR OF FINANCE

- Enables cheap loans for CPCU
- Direct loans.
- Sometimes pays for extending the network inside the new zone
- Pools investment with other municipalities

PROVIDER AND CONSUMER

- Anchor loads (public buildings, hospitals, social housing).
- Network runs through parts of the metro system
- Direct ownership of network in the city.
- Sets maximum heat tariffs and sets a special low tariff for social housing

COORDINATOR AND ADVOCATE

- Urban Development Zones will develop mandatory connection once more than 50% renewable (2015)
- Strategy and targets: 60% renewable by 2020.



MODULE 6. BUSINESS MODELS, FINANCE & PROCUREMENT

CASE STUDY: PARIS, FRANCE

Benefit of private sector

- Private sector reduces risk associated with generation and distribution of heat with the involvement of local government.
- Private sector benefits from mandatory connections policy (after reaching 50% renewables share).
- CPCU is self-financing and more efficient as city of Paris is only a part owner.
- City of Paris helped secure demand for CPCU from publicly owned buildings having high heat density.



Source: District Energy in Cities. Unlocking the Potential of Energy Efficiency and Renewable Energy



MODULE 6. BUSINESS MODELS, FINANCE & PROCUREMENT

CASE STUDY: YEREVAN, ARMENIA

Status of DHN

- No domestic fossil fuel resources, import natural gas, DH supply up until 1990s
- Today: individual heat solutions: wood, kerosene, electricity, gas boilers
- District heating on existing network 60% > expensive domestic gas-fired boilers
- Low-reliability, poor maintenance, heat losses, low collection rates



Source: District Energy in Cities. Unlocking the Potential of Energy Efficiency and Renewable Energy

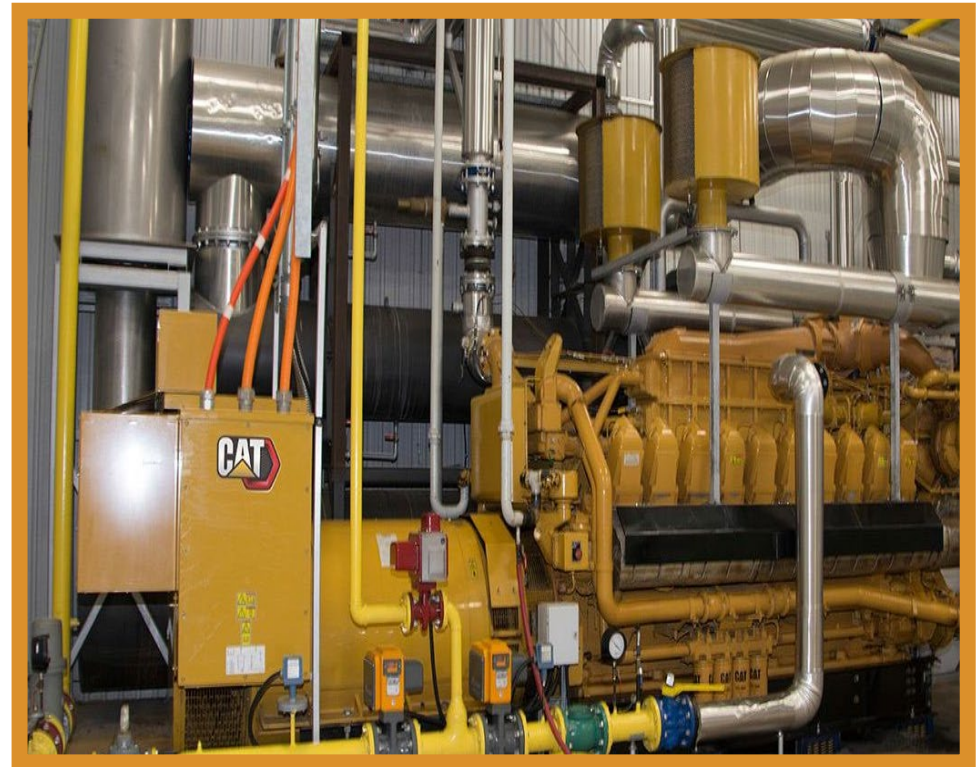


MODULE 6. BUSINESS MODELS, FINANCE & PROCUREMENT

CASE STUDY: YEREVAN, ARMENIA

Pilot project in Yerevan

- Cogeneration on DHN could deliver 16 AMD/kWh of heat compared to boiler houses on DHN delivering 22.7 AMD/kWh **if electricity is used**
- ArmRusCogeneration CJSC, restore network, build CHP
- Yerevan minority shareholder
- Government Decision guaranteeing purchase at favourable price of electricity produced by new cogeneration units of the district heating project.

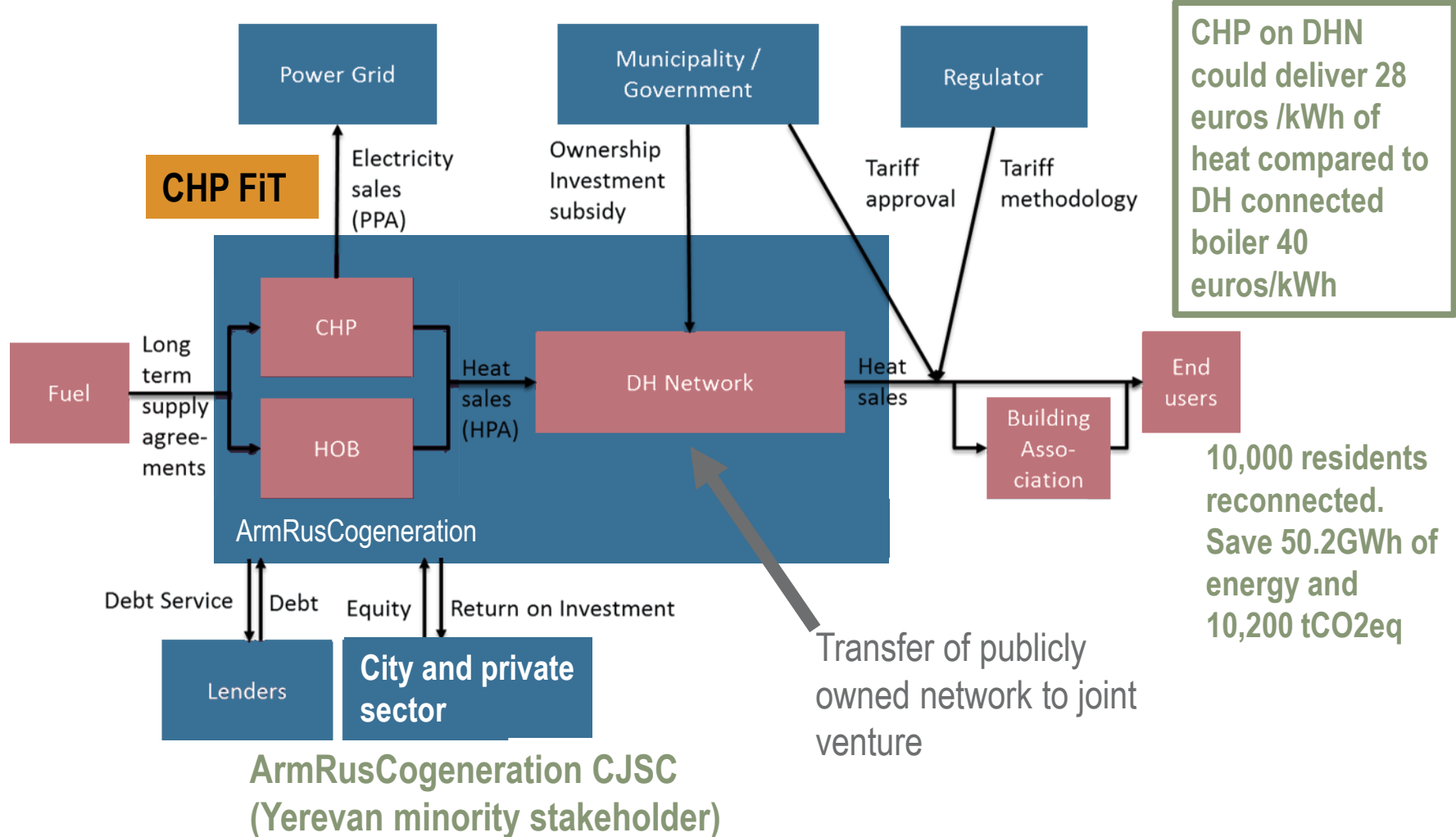


Source: Cat

MODULE 6. BUSINESS MODELS, FINANCE & PROCUREMENT

CASE STUDY: YEREVAN, ARMENIA

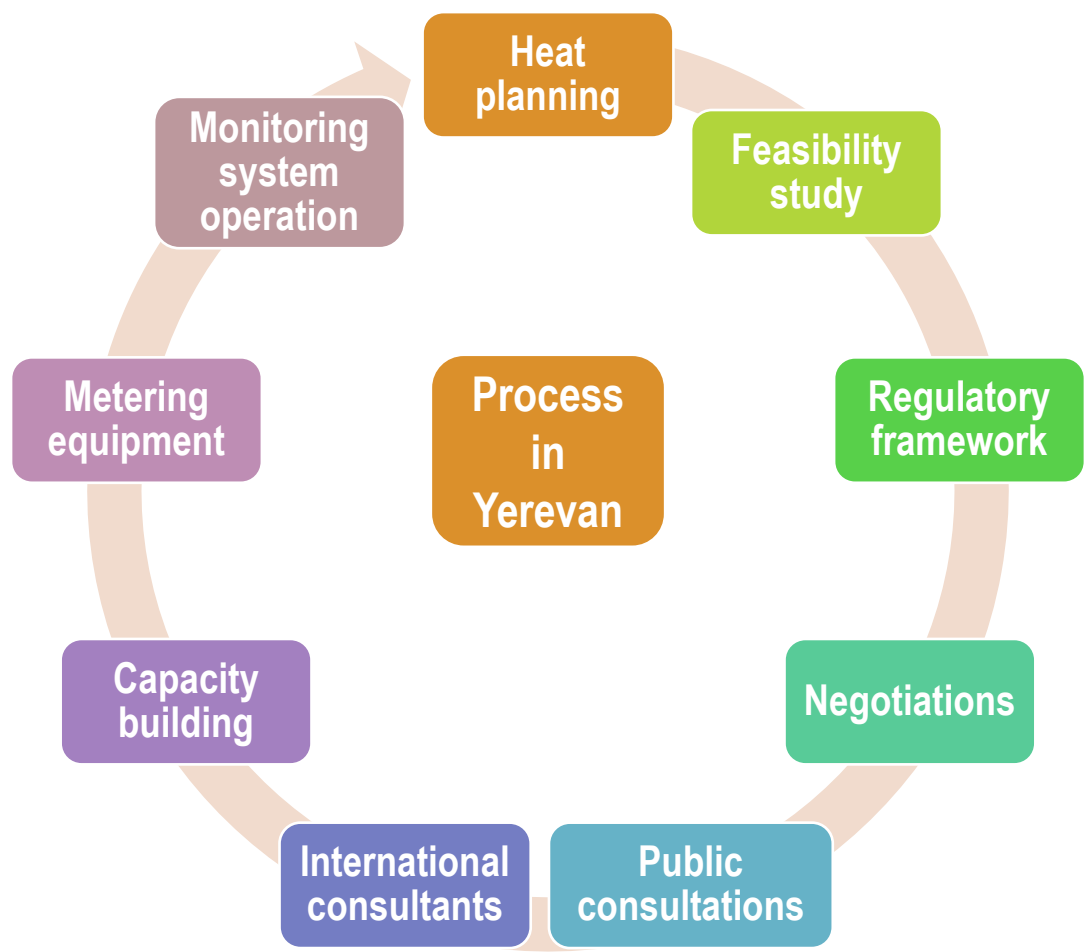
Joint venture model





CASE STUDY: YEREVAN, ARMENIA

Process of developing DES in Yerevan





CASE STUDY: YEREVAN, ARMENIA

The role of local governments

PLANNER AND REGULATOR

Worked with national government to apply

- multi-part heat tariff < alternative
- preferential electricity feed-in tariff (internalizing benefit of heat in the electricity price) < marginal price

FACILITATOR OF FINANCE

- Free use of municipally owned DH infrastructure to enable PPP demonstration project.
- Leveraged more than 9 million USD of FDIs for restoration of district heating system

PROVIDER AND CONSUMER

- Utilising municipally owned district heat companies as an investment vehicle for upgrading networks.
- Setting waste heat tariff from steel plant to pay off investment in connection.

COORDINATOR AND ADVOCATE

- Cities role will be in coordinating multiple district heat companies.
- Advocating system to other cities in the region.



MODULE 6. BUSINESS MODELS, FINANCE & PROCUREMENT

CASE STUDY: ANSHAN, CHINA

The current problem

- 42 different district heating companies, some networks owned by the city and some are privately owned.
- High pollution levels with current system: fined US\$1.3 million in 2013 by Liaoning province for high levels of PM10, SO2 and CO2.
- Some networks have overheating and under-heating.
- Lack of hot water connections means networks are underutilised.



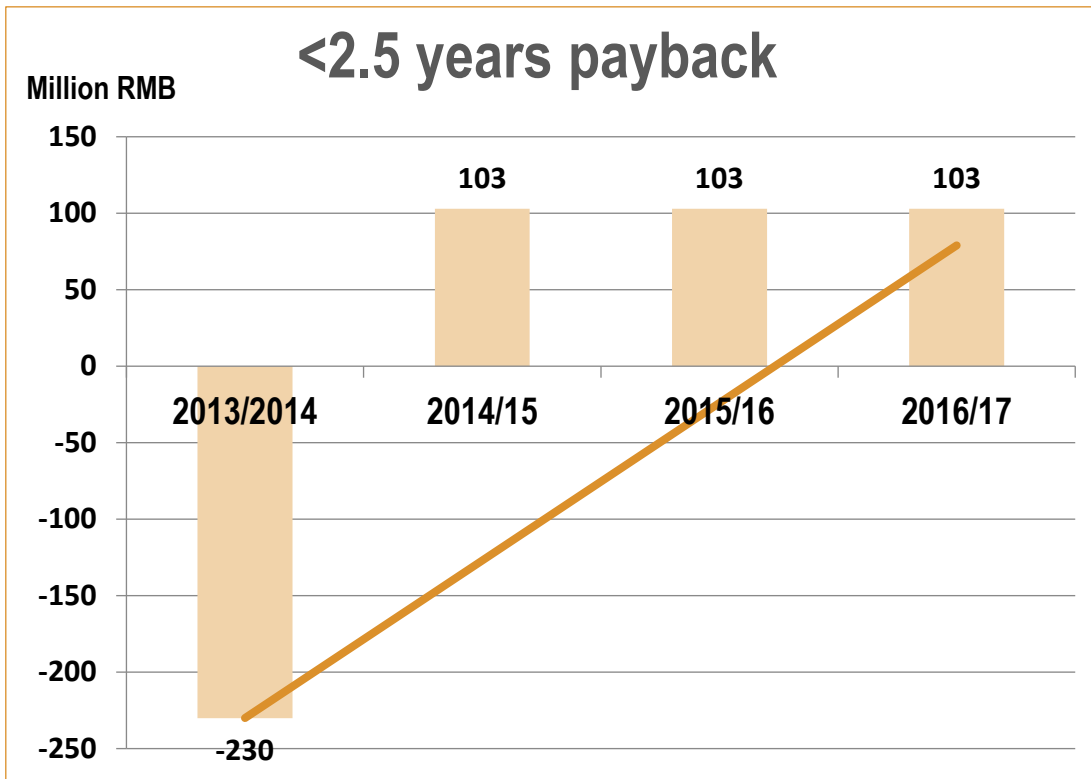
Source: Danfoss



MODULE 6. BUSINESS MODELS, FINANCE & PROCUREMENT

CASE STUDY: ANSHAN, CHINA

Investing in waste heat



220 MW available surplus heat (1st phase)

Yearly energy saving	830,000 MWh
Coal savings	173,000 tons
C02 emission savings	290,000 tons

Yearly savings	103 million RMB (15 million euros)
Investment	200-230 million RMB (30 – 35 million euros)

Source: Danfoss



CASE STUDY: ANSHAN, CHINA

The role of the private sector

- Local government worked with Danfoss and COWI to design more sustainable and integrated heating solutions for the city.
- Danfoss supplied heat exchangers for waste heat connection to steel plant
- The new transmission line will be owned and operated by a joint venture that is 60% city owned and 40% private. The construction will be sub-contracted to individual contractors.
- All existing district heat companies will remain, purchasing heat from the central transmission company.



CASE STUDY: ANSHAN, CHINA

The role of local governments

PLANNER AND REGULATOR

- Developed with the help of private sector a new strategy for district heat development in city.
- City's focus on pollution reduction is key driver in transforming system.

FACILITATOR OF FINANCE

- Directly financing majority of improvements in the city including connection of waste heat and a transmission line.
- Large city investment has leveraged private investment in transmission line.

PROVIDER AND CONSUMER

- Utilising municipally owned district heat companies as an investment vehicle for upgrading networks.
- Setting waste heat tariff from steel plant to pay off investment in connection.

COORDINATOR AND ADVOCATE

- Cities role will be in coordinating multiple district heat companies.
- Advocating system to other cities in the region.



MODULE 6. BUSINESS MODELS, FINANCE & PROCUREMENT

CASE STUDY: ANSHAN, CHINA

Benefits for the private sector

- Danfoss bring international expertise in district heating development
- Anshan use less coal and thus pollute less.
- Investment provided from private sector in transmission line reduces risk to city and allows funds to be used elsewhere.



Source: Rincewind42



KEY TAKEAWAYS

Some of the main aspects we have seen in this module are:

- **Business models are key to ensure a stable and viable DES service** during its complete life-cycle (development, operation, end-of-life)
- **Business model can have a large influence on a project's perceived risk and funding costs**
- **No single model is applicable everywhere**
- **DES business models based on ownership type, these are:** Fully public model, PPP/hybrid and Privately owned.
- **The relative involvement of the public or private sector depends broadly on two factors: (1)** return on investment for project investors, and (2) degree of control and risk appetite of the public sector.
- **The city can facilitate finance through various instruments**, such as: demonstrating new technologies, new policies, creating city assets, debt provision and bond financing, tax credits and exemptions, loan guarantees and underwriting, securing and providing grants, or setting up a revolving fund.
- **Regulation can act as an incentive, particularly in less mature DE markets**



MODULE 6. BUSINESS MODELS, FINANCE & PROCUREMENT RECOMMENDATIONS

Some recommendation for business models, finance and procurement are:

- **Publicly-owned infrastructure** is often recommendable since it will often require significant efforts of community engagement
- Identify where **competition** can be introduced, for example in the production parts through tenders
- Continuous communication between various **stakeholders**
- **Removal of regulatory barriers** as well as **optimising and simplifying the regulations** at the local and national level, should be promoted.
- Picking low-hanging fruits: **start with high-demand consumers** – while making sure the full potential can be exploited
- Frameworks for providing **low-cost financing options** and avoiding (unnecessary) administratively-heavy processes is an important precondition to effectively engage communities and industries.
- Development of **insurance schemes** to de-risk renewable sources such as geothermal
- Set up a **comprehensive district energy governance scheme**, including price regulation, ownership and legislation



CONGRATULATIONS! YOU HAVE NOW COMPLETED THIS E-TRAINING!

For more information about the initiative or this Training, please visit the following websites or contact:



www.districtenergyinitiative.org



unep.org



c2e2.unepdtu.org