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

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
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**

The role of a solid business model in District Energy projects

Leverage lower cost to finance needed to ensure investment

Attract & engage investors, operators, utilities, consumers, local authorities

Cater projects’ good functioning and operations of the project

Ensure project stability and longevity

“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
A business model is defined as ...

The main components of a business model are

- **Core Strategy**
  - Business mission
  - Product/market scope
  - Basis for differentiation

- **Strategic Resources**
  - Core competencies
  - Strategic assets

- **Partnership network**
  - Suppliers
  - Partners
  - Other key relationships

- **Customer interface**
  - Target customer
  - Fulfilment and support
  - Pricing structure

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

Characterization of Business Models

**Main elements of a business model**
- **Partnership**
  - E.g. public and private partnerships (PPP)
- **Revenue streams**
- **Key activities**
- **Key resources**
- **Value proposition**
- **Customer relationship**
- **Channels**

**Cost structure**
- Heating/cooling sales
- Power sales
- Connection charges
- Ancillary services
- Capacity payments

**District energy** typically has high CAPEX & relatively low OPEX

- Grouped according to locations, building uses or energy demands
- Special segments: (risk of) energy poverty and "prosumers"

**Physical distribution energy network**
- Ownership structure

**Best Practices**
- **Procurement**
- **Finance instruments**
- **Business models**

**Context**
- Individual end-users level
- Societal level (local/national)

- Planning & construction of network system
- Monitoring & control mechanisms

- Financial
- Technical
- Fuel resources

- Communication between utility & end-user is during; welcome to utility, bill receipt, season change, rate change & contract anniversary.
## Characterization of Business Models

### Fully public models
- High degree of control
- Potentially high degree of coverage
- Medium/low returns
- High public risk

### PPP/hybrid models
- Medium degree of control
- Coverage based on negotiations
- Medium/high returns
- Medium public risk

### Privately owned models
- Low degree of control
- High returns
- Medium/low public risk

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Source: District Energy in Cities. Unlocking the potential of Energy Efficiency and Renewables
Business model, based on degree of control, return and risk

Source: Bloomberg New Energy Finance
Private sector participation in PPPs

Source: Ang and Marchal, 2019
## DE business models for real estate developers

<table>
<thead>
<tr>
<th>Developer Equity</th>
<th>Potential Equity Investors</th>
<th>DE Operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>In House</td>
<td></td>
<td>Internal/O&amp;M or Management contractor</td>
</tr>
<tr>
<td>Joint Venture SPV</td>
<td></td>
<td>Developer equity/DE operators/Other equity investors</td>
</tr>
<tr>
<td>Full Concession</td>
<td></td>
<td>DE operators</td>
</tr>
</tbody>
</table>

- **100% Developer equity**
  - Developer retains risk but has full control
  - O&M or management can be contracted
  - Potential sale or concession post-completion

- **<50% Developer equity**
  - Equity partner shares cost and risk
  - Partner may bring operational expertise

- **0% Developer equity**
  - Max risk transfer
  - 25 – 50 year BOOT contract
  - 3rd party finance

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

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.

• **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.

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**Inner city network costs, Sweden.**

- Earthworks, traffic control and restoration of road surface: 61%
- Plumbing and installation of pipes: 19%
- District heating pipes, insulation, valves and fittings: 11%
- Project development and planning: 9%
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.


Note: CHP heat tariff in graph calculated from required return after electricity revenue
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
Facilitate Finance (Cities)

- Demonstrating new technologies
- Demonstrating new policies
- City assets
  - Debt provision and bond financing
  - Tax credits and exemptions within tax systems
- Loan guarantees and underwriting
- Securing and providing grants
- Setting up a revolving fund

‘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.
Investor understanding of investments per project phase

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

Source: DHC Think tank to Unlock Investments in DH
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.
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
 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
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 customers
- 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 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
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
District Heating Regulation

- 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)
• 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

CASE STUDIES

Yerevan, Armenia Source: Unsplash
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.

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.
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
Split asset concession model: Public/Private Concessionaire

- **Power Grid**
  - 1 TWh per year
  - Electricity sales

- **Municipality / Government**
  - Concession Agreement
  - 7 million euros per year
  - Reporting
  - Tariff approval
  - Tariff methodology

- **Regulator (Paris)**
  - 19.5 million euros calculated benefit to city per year

- **DH Network (owned by city, operated by CPCU)**
  - 5.5 TWh per year
  - Heat sales

- **CHP and Waste-to-energy**
  - Gas, Biomass, Waste etc.

- **CPCU (public/private)**
  - Lenders
  - Debt Service
  - Debt
  - Shareholders
    - 33% City of Paris
    - 64% Cofely
  - Equity
  - Return on Investment
    - 2 million euros dividend to City

- **End users**
  - 100% Hospitals
  - 50% Social Housing
  - 50% of public buildings

- **Waste-to-energy plants are owned by regional agency.**
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.
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.

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

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.
Case Study: Yerevan, Armenia

Joint venture model

- City and private sector
- Municipality / Government
- Regulator

ArmRusCogeneration CJSC (Yerevan minority stakeholder)

CHP on DHN could deliver 28 euros /kWh of heat compared to DH connected boiler 40 euros/kWh

10,000 residents reconnected. Save 50.2GWh of energy and 10,200 tCO2eq
Process of developing DES in Yerevan

- Capacity building
- International consultants
- Public consultations
- Negotiations
- Regulatory framework
- Process in Yerevan
- Monitoring system operation
- Metering equipment
- Feasibility study
- Heat planning
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.

**BEST PRACTICES**

**PROCUREMENT**

**FINANCE INSTRUMENTS**

**BUSINESS MODELS**

**CONTEXT**
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
CASE STUDY: ANSHAN, CHINA

Investing in waste heat

- Yearly energy saving: 830,000 MWh
- Coal savings: 173,000 tons
- CO2 emission savings: 290,000 tons
- Yearly savings: 103 million RMB (15 million euros)
- Investment: 200-230 million RMB (30 – 35 million euros)

<2.5 years payback

Source: Danfoss
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.
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.
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
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.
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