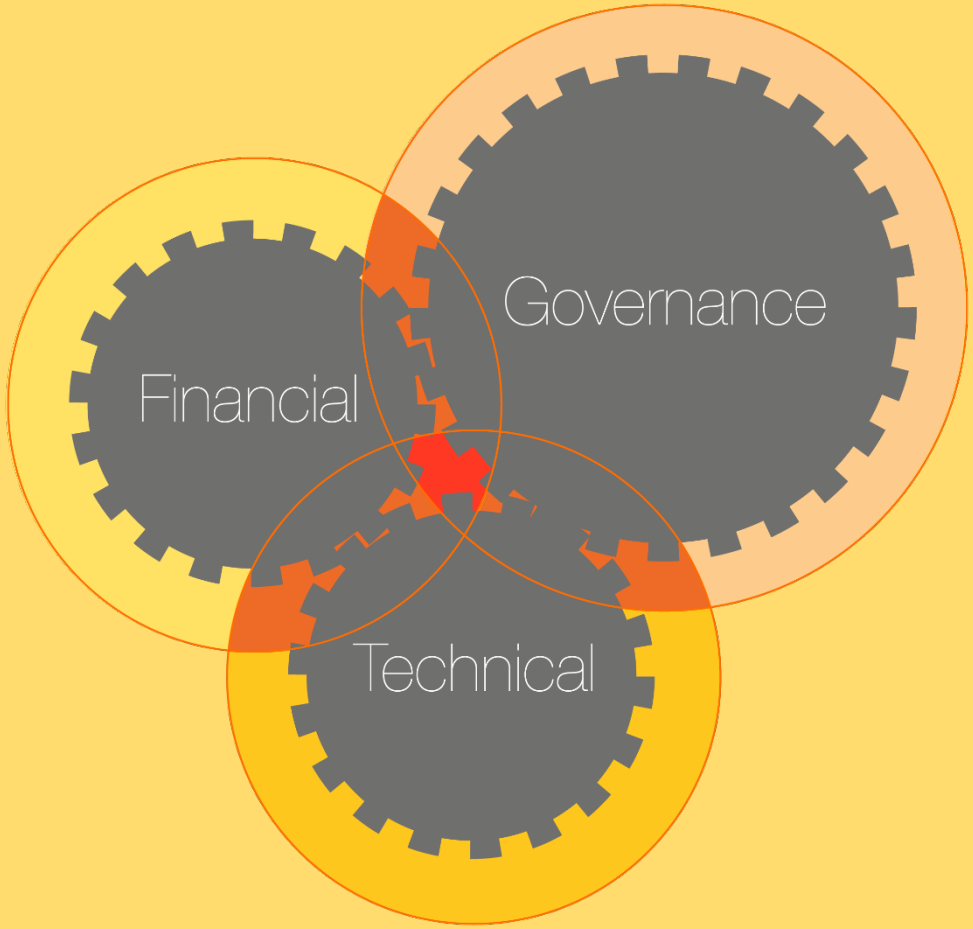
The Political, Economic & Social Context



Anna Chittum, GridKraft

The Political, Economic & Social Context

Trends shaping DE deployment today

- *Nodal development*
- *Integration of renewable resources*
- 4th Generation DH/hot water conversions
- Net-zero energy/emissions goals
- Changing electric mix
- Thermal/electric grid integration
- Resilience goals/critical infrastructure
- Political unknowns

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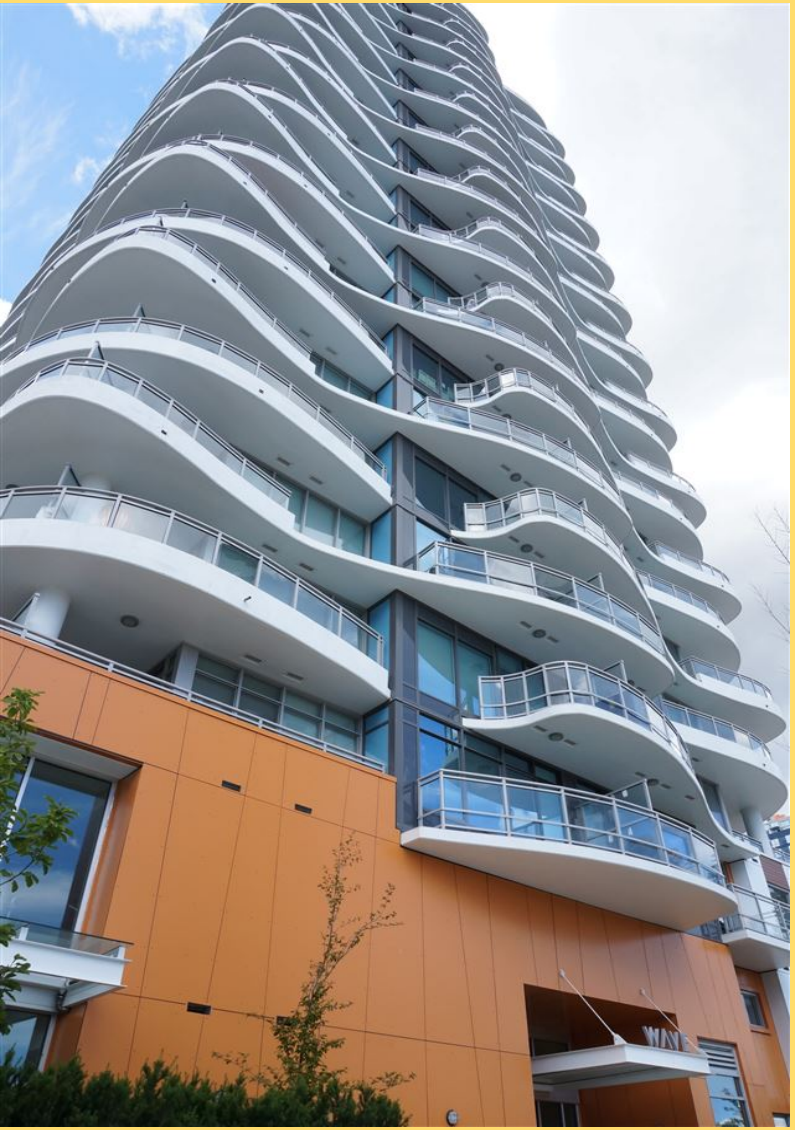

The Wave Building in Surrey. Photo by I Love False Creek.

Nodal development

Surrey City Energy, Surrey City, BC, Canada

- Temporary gas boilers to buy time
- Assessment of hyper local waste resources
- Long term: connect nodes to enhance economies of scale
- Plan to integrate renewable resources in near future

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McMaster Innovation Park. Photo by Daisy Energy 2016

Integration of Renewable Resources

Hamilton Community Energy
McMaster Innovation Park, Hamilton, ON, Canada

- Geo-exchange banks + solar + natural gas
- 37 acres: offices, labs, conference spaces
- Base load: solar thermal
- Shoulder: geo-exchange bank (500’ wells)
- Peak: natural gas boilers

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Major drivers influencing DE deployment today

- **Economic drivers**
  - Revenue generation
  - Economic development
- **Environmental drivers**
  - Air quality
  - *Climate change mitigation*
- **Social drivers**
  - Fuel poverty
  - Stable energy costs
  - *Resilience*

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Environmental drivers

Louvre Museum. Photo by Jean-Pierre Dalbéra

Paris, France

- EU and city climate goals
  - City goal: GHGs reduced 75% of 2004 by 2050; renewable DH key to that
- Increase in existing carbon tax
- DH company had goal to increase share of renewables from 49% to 60% by 2012
- City asked: reach 75% by 2020

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Resilience drivers

- Thermal resilience
  - ❑ Phoenix: cooling
- Electric system resiliency (ancillary benefit)
  - ❑ University of British Columbia

Pipes going in at University of British Columbia. Photo by UBC

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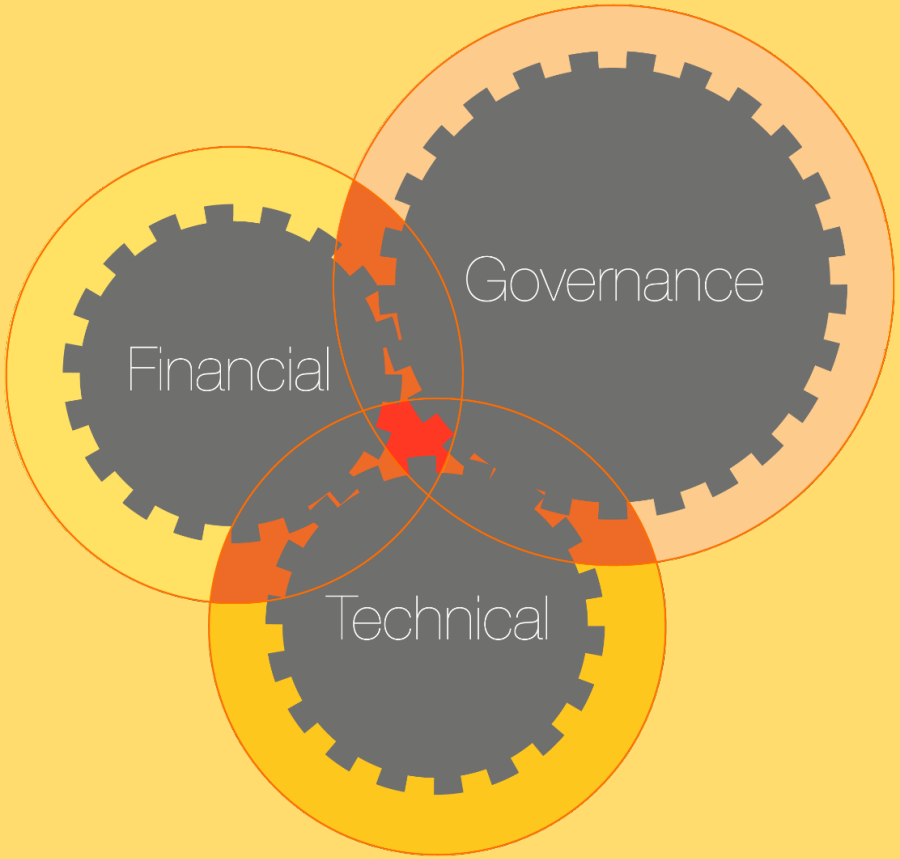
Panel Discussion



Bruce Ander, President & CEO, Markham District Energy

Jong Jun Lee, Senior Researcher, KDHC

Michael King, Director, District Energy Development LLC.

Moderator: Anna Chittum, Gridkraft

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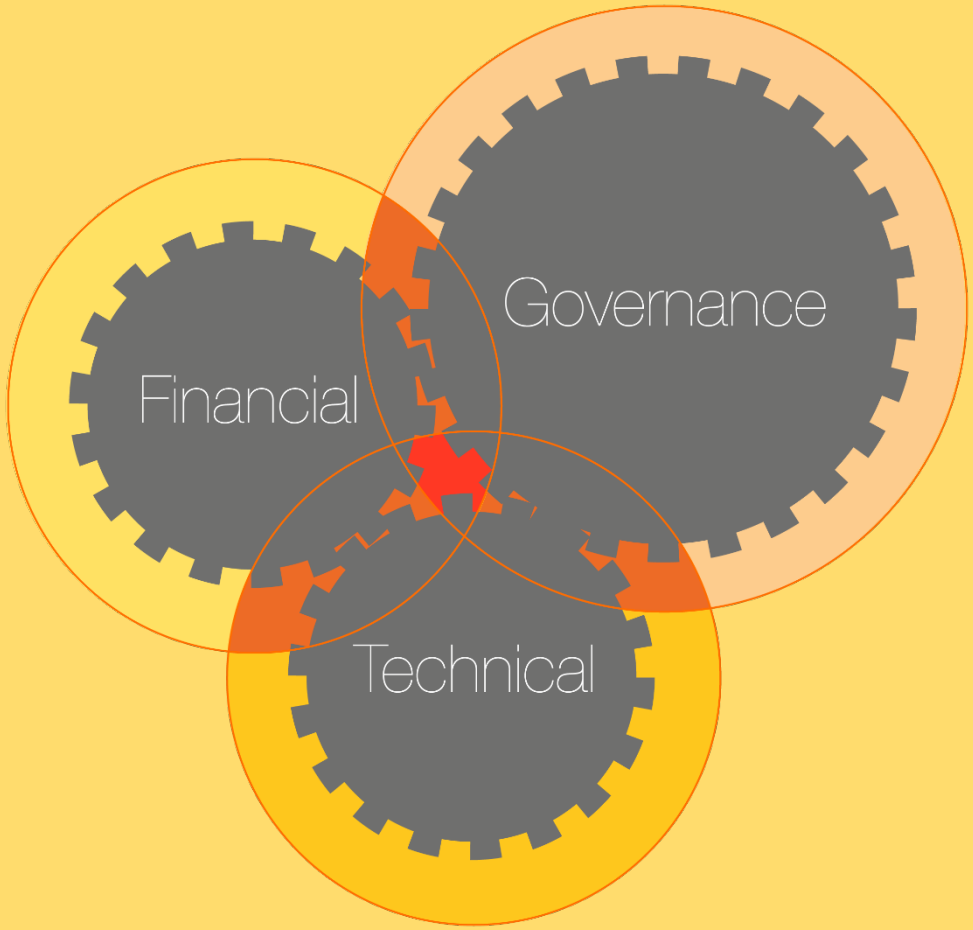

Canada

Bruce Ander, Markham District Energy

Economic Drivers: Canada

Revenue Generation

Toronto Enwave

- city enjoyed annual dividends and user fees that helped strengthen the municipal coffers
- city in collaboration with the majority owner OMERS – sold the system to a private entity for a substantial profit ($168M CAD) and used money for other operating needs,.

Increasing Local Economic Competitiveness

Vancouver – South East False Creek DE System

- rate structure does not front-load the initial capital investments
- so early adopters are not penalized for connecting to the system
- rate strategy balance up-front capital costs for early adopters by sharing them with those that connect later
- helps attract new development investment

Boosting Value of Existing Resources

Toronto and **Vancouver**

- latent thermal energy resources in the lake and the sewer system, respectively, only became valuable economic assets when they were turned into a resource by the DE systems

Environmental Drivers: Canada

Meeting Emission Reduction Goals

Vancouver – South East False Creek DE System

- primary driver of investment was to support the Olympic Games housing development carbon dioxide reduction goals.
- fundamental aspect of the system planning and development was to highlight the business case for investment in such a system
- show developers that such a system was economically viable and indeed preferable to business-as-usual heating resources.

Enwave's Deep Lake Water Cooling:

- 79,000 tonnes of CO2 removed annually (based on displacement of coal power generation at the margin) equivalent of taking 15,800 cars off the road.

Social Drivers: Canada

Strengthening Communities

Vancouver – South East False Creek DE System

- a rate stabilization fund helps keep rate increases in check
- cost for this fund was embedded in the initial assessment of capital costs, so that over the long term, rates will pay back the rate stabilization fund "investments."

Success Strategy-Managing Drivers & Challenges

A Few Observations for our Discussion:

1. There are very few district energy systems that are the technically the same; Southeast False Creek and Enwave are two great examples of our industry's diversity.
2. Taking advantage of a local opportunity is key:
   - Olympic Village project (Vancouver)
   - City considering lake water for its future drinking water supply (Toronto)
3. Too often focus on rates (is our solution a 'cheaper' rate solution than the status-quo) which often drives decision makers to the shorter term, low cost alternative.
4. Customer connection and retention is a challenge that all DE systems share – mandatory connection is not always the solution.
5. There is no one ownership or governance model that is superior – private, public-private, to government control – they all have their application and pros/cons.

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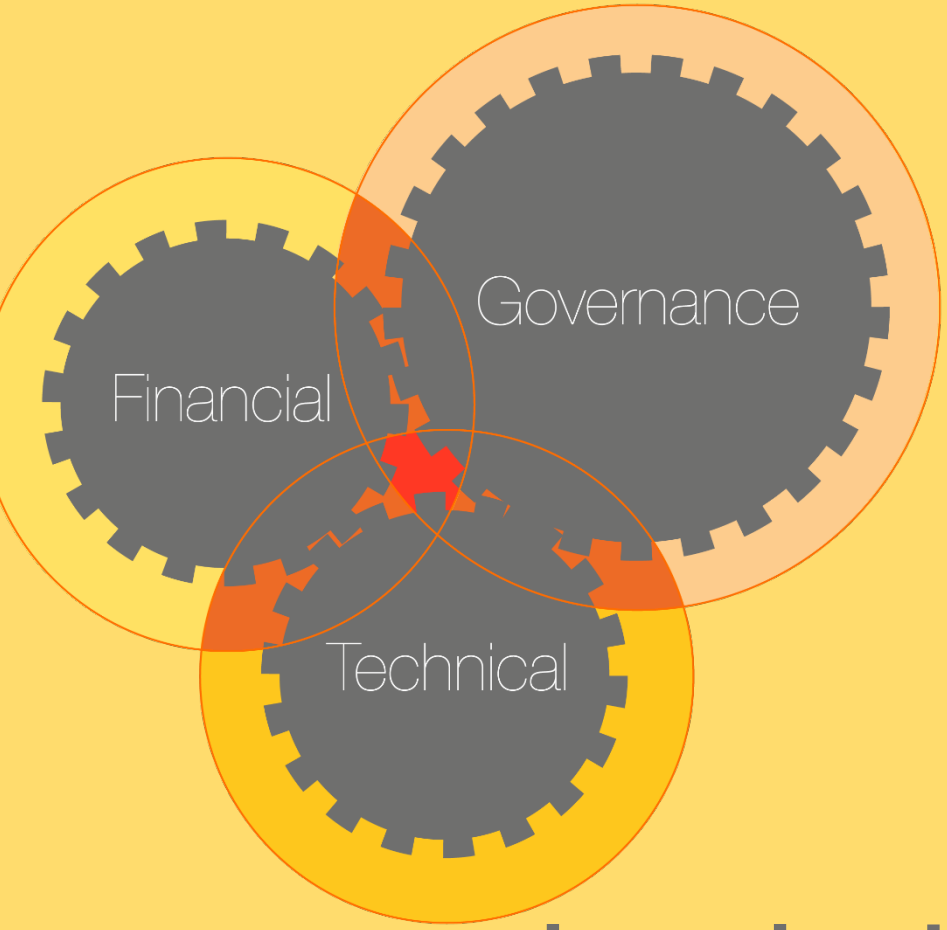


South Korea

Jong Jun Lee, Korea District Heating Corporation (KDHC)

What Is Driving DE Development in S. Korea?

Economic Drivers

Revenue

- The **Sang-am** area, a part of Seoul Metropolitan city, enjoys a regular revenue stream for the waste from its waste management system, which the DE system pays for as its primary fuel.
- Previously managing the waste in landfill was a cost!

Increasing Local Economic Competitiveness

- The landfill gas that is used by the district system was already available.
- By using solid waste for this productive purpose, the city could reduce the amount of waste that would otherwise stagnate in landfills.
- Land is very scarce in Sangam, so freeing up land for other, higher-value uses helped economic development.

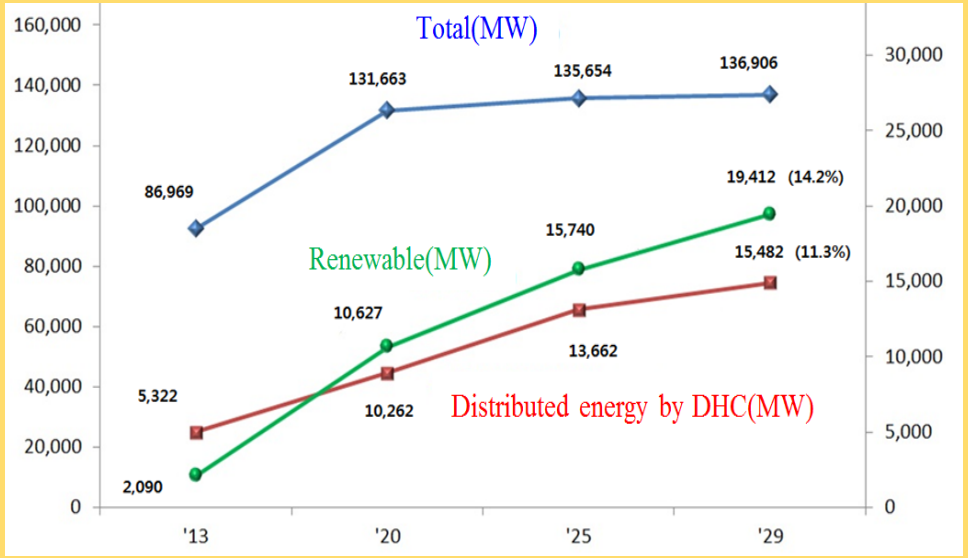
What Is Driving DE Development in S. Korea?

Environmental Drivers

Stimulating Growth of Renewable Energy

- **Sang-am area**, the part of Seoul, South Korea, responded to national goals requiring DH resources to be at least10% renewable by 2022.

- With the establishment of waste-to-energy as a renewable resource, the city took advantage of its existing waste resources and made productive use of them.



(Unit :MW)

	'13	~'20	~'25	~'29
Total	86,969	131,663	135,654	136,906
Distributed Energy by DHC	5,322	10,262	13,662	15,482 (11.3%)

<The plan for distributed power generation in South Korea>

What Is Driving DE Development in S. Korea?

Social Drivers

- In S. Korea, large size housing developments must utilize District Energy
- The government competitively selects a company to offer these services.
- This ensures that the new developments will offer future tenants low-cost energy, impacting a large portion of the population immediately, because so many people reside in these housing developments.
- As an additional driver, the Sang-am district was able to transform what was formerly a landfill into a desirable residential area.

The history of KDHC

- In 1978 : The Korea government considered to introduce DHC
  - ➢ Energy conservation & greenhouse gas reduction

- In 1985 : Established Korea District Heating Corp.

- In 1991 : Development of new cities of metropolitan area
  - ➢ Adopting “The Act of District Heating and Cooling”
  - ➢ The new city must be provided DHC(if the city exceed certain scale)

- In 2001 : Structure reforming of electric power industry
  - ⇨ DHC companies entering the electric power market

Current Status of KDHC

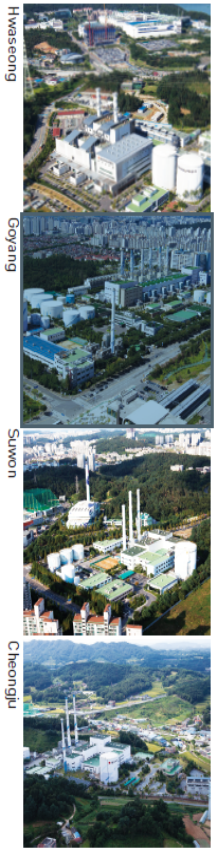
The Annual trend of district heating propagation in Korea

	'95	'00	'05	'10	'11	'12	'13	'14
Total (thousand)	9,570	11,472	13,222	14,677	15,007	18,551	18,884	19,217
Supply (thousand)	525	980	1,390	2,008	2,178	2,220	2,323	2,436
Supply rate(%)	5.5	8.5	10.5	13.7	14.5	12.1	12.3	12.7
Number of Companies	2	8	15	26	28	33	34	36

- The Propagation rate of DHC are increased more than twice(5.5 → 12.7%)

- The trend of DHC in Korea
  - ➢ 36 district heating companies(59 sites)
  - ➢ 2.43 million households
  - ※ KDHC : 1.3million households and 2,100 buildings

Current Status of KDHC



Status of Branches

Name	Heat supply started	Main service area	Telephone
Mapo (Dangindong)	1987. 11	Yeouido, Ichon, Banpo etc.	82-2-305-2488
Bundang	1991. 9	Bundang etc.	82-31-702-2295
Gangnam	1991. 10	Gangnam, Seocho, Songpa etc.	82-2-459-2488
Goyang	1992. 8	Ilsan, Hwajeon, Haengsin etc.	82-31-900-2488
Yongin	1994. 12	Suji, Jukjeon, Dongback etc.	82-31-262-2488
Daegu	1995. 4	Seongseo, Daegok etc.	82-53-589-4114
Suwon	1995. 10	Youngtong, Gweonseon, Cheoncheon etc.	82-31-201-0114
Cheongju	1997. 5	Bunpyeong, Habokdae etc.	82-43-234-2488
Gyeongnam (Yangsan)	1999. 11	Mulgem etc.	82-55-388-2477
Gyeongnam (Gimhae)	2000. 7	Jangyu etc.	
Mapo (Sangamdong)	2001. 7	Worldcup stadium, Sangam New Town	82-2-305-2488
Hwaseong	2004. 3	Dongtan, Taean, Byeongjeom etc.	82-31-374-2188
Paju	2005. 10	Gyoha, Unjeong etc.	82-31-957-2961
Pangyo	2008. 11	Pangyo	82-31-706-2488
Gwangyo	2011.10 (scheduled)	Gwangyo etc.	82-31-693-8588
Samsong	2011.11 (scheduled)	Samsong, Eunpyeong New Town etc.	82-2-356-2488

Status of Subsidiary Companies

Company	Established date	Main business	Telephone
Korea District Heating Engineering Co., Ltd.	1991. 11. 1	Integrated energy engineering business	82-31-776-8888
Incheon Total Energy Service Co., Ltd.	2004. 6. 10	District heating supply to Songdo New Town, Incheon City	82-1577-1079

<Connected network in Metropolitan area>

Current Status of KDHC (2014)

- 18 district branches
  (Dongtan & Naju are under constructing)
- 1.3 million households
- 2,100 buildings

Comparison table('87 vs '12)

Items	Beginning ('87)	Present (as of '12)	Note
Assets (m$)	50	4,500	X 90 ↑
Sales (m$)	1.6	2,600	X 1,625↑
Consumers (residents)	39,491 households	1,211,858 households	X 30↑
Consumers (commercial, etc)	38 places	2,336 places	X 60↑
Heat supply (Total capacity)	0.1 Gcal/yr (387 Gcal/h)	12 mGcal/yr (7,398 Gcal/h)	X 120m↑ (X 19)
Power supply (Total capacity)	0 (0)	9 GWh/yr (3,812 MW)	
Employee No. (Branches)	111 (1)	1,312 (16)	X 10↑ (Nation wide)

Integrated Energy Supply Zone

The Ministry of MOTIE has the authority to designate a mandatory zone to use the heat produced by IES. The advisory committee reviews the feasibility of IES in the zone. Any heat source other than IES in the zone should earn a license from MOTIE.

Target Zone

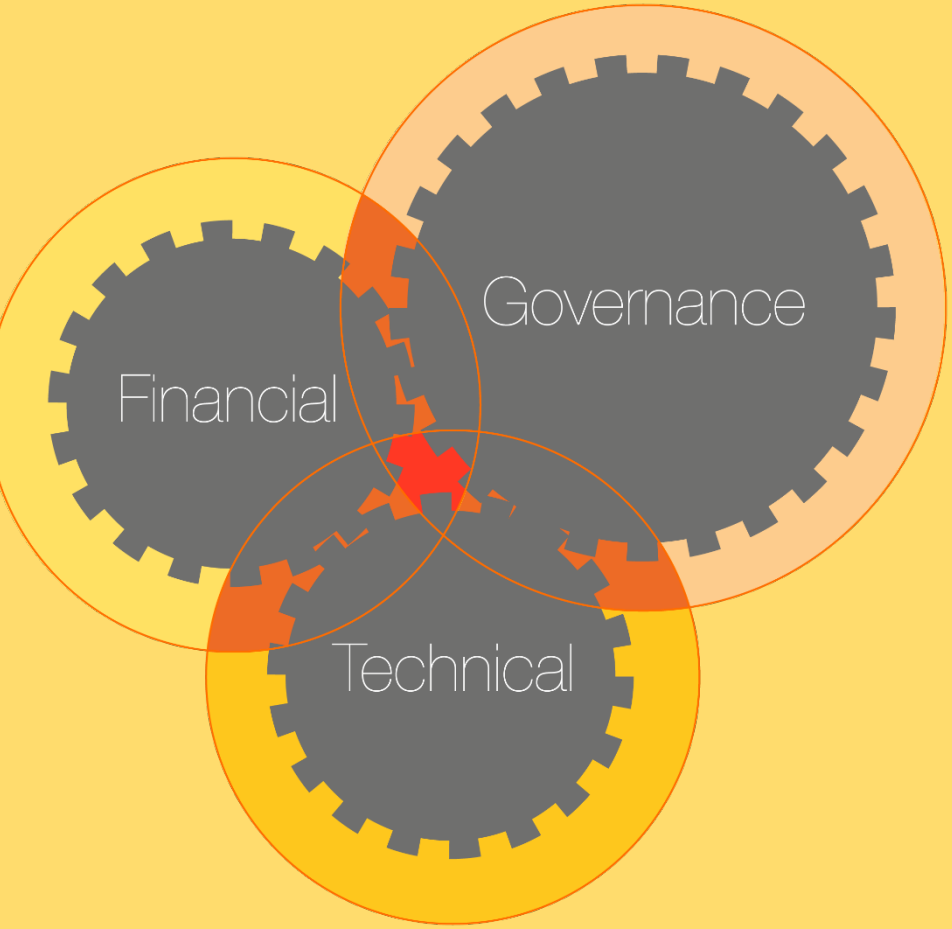
- Housing Construction
  : ≥ 5,000 households
- Or Housing Development Project
  : ≥ 600,000m3
- Or Industrial Complex Development Project
  : ≥ 300,000m3

Expected Energy Demand

- District Heating and Cooling
  - Max Heat Load : ≥ 100Gcal/h
  - Energy Consumption : 180,000Gcal/y
  - Heat Density : 20Gcal/km2h
- Industrial Complex
  - Energy Consumption : ≥ 50,000 TOE
  - Heat Density : ≥ 60Gcal/km2h
  - Power Capacity : ≥ 20,000kW

Submit an application for IES feasibility consultation	MOTIE (Ministry of Trade, Industry & Energy)
Conduct a feasibility consultation of the zone	Korea Energy Agency
Give preliminary notice to designate the zone	MOTIE (Ministry of Trade, Industry & Energy)
Take opinions from and negotiate with the interested parties	MOTIE (Ministry of Trade, Industry & Energy)
Conduct a comprehensive review of the feasibility of IES	IES Zone advisory committee
Give public notice of designation of IES zone	MOTIE (Ministry of Trade, Industry & Energy)

The Political, Economic, & Social Context



United Kingdom

Michael King, District Energy Development Ltd

What Is Driving DE Development in UK?

Environmental Drivers

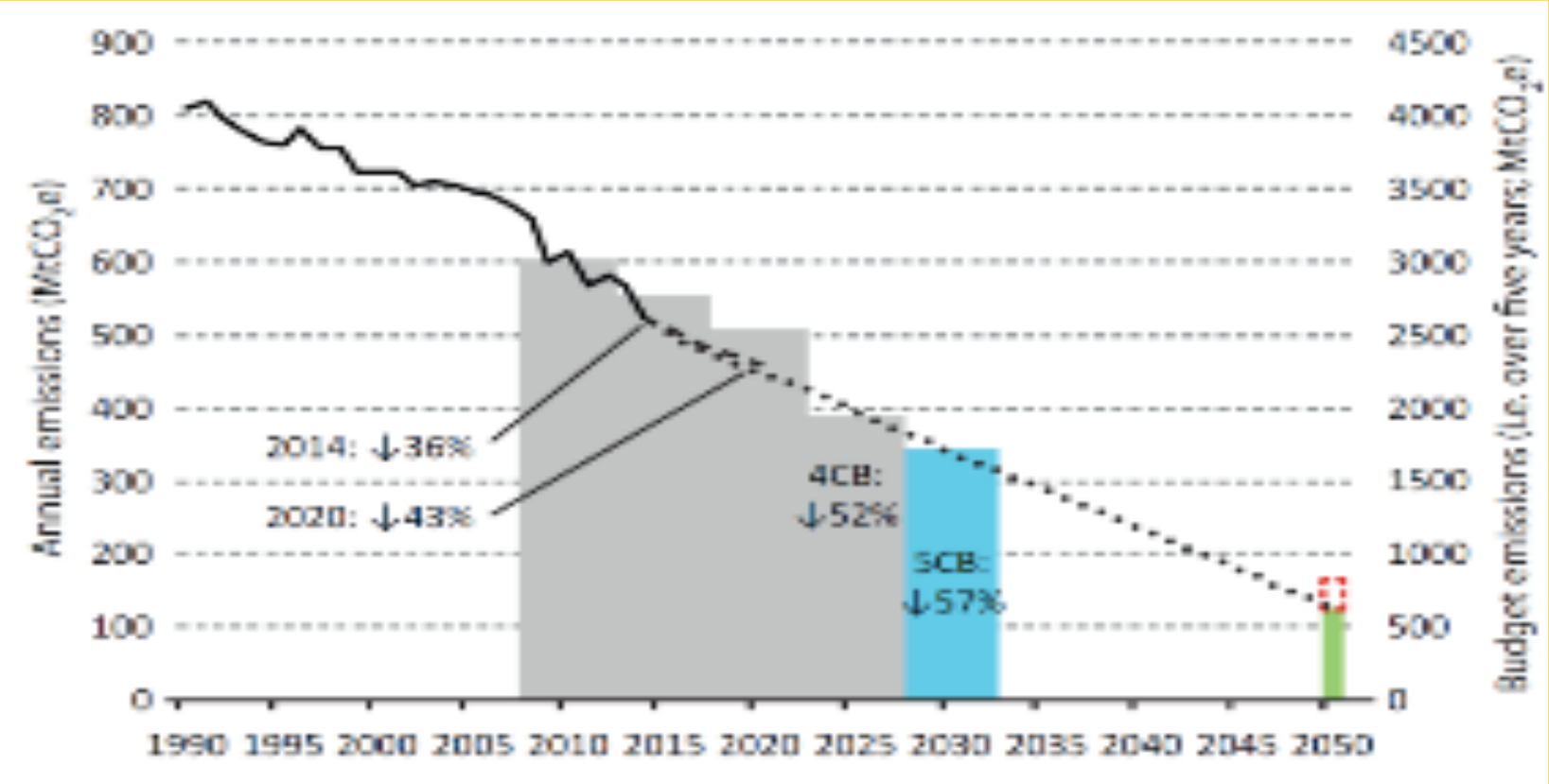
Climate Change Act 2008

- Target of 80% reduction in carbon emissions by 2050 against 1990 baseline
- Across total economy – power, transport, industry, agriculture & heat.
- Electricity sector to make deeper cuts to accommodate more challenging sectors
- Establishes Committee on Climate Change (CCC) to advise Govt. on progress
- CCC activity divided into 5 year Carbon Budgets (2008 – 12, 2012 – 17 etc)
- Each assesses emissions in budget period and recommends adjustments.
- 4th Carbon Budget for 2023 – 2027 published.
- Working on 5th Budget 2028 – 32
- Particular focus on heat. Publishes report ' *Next Steps for UK Heat Policy*' (Nov 2016)
- https://www.theccc.org.uk/publication/next-steps-for-uk-heat-policy/

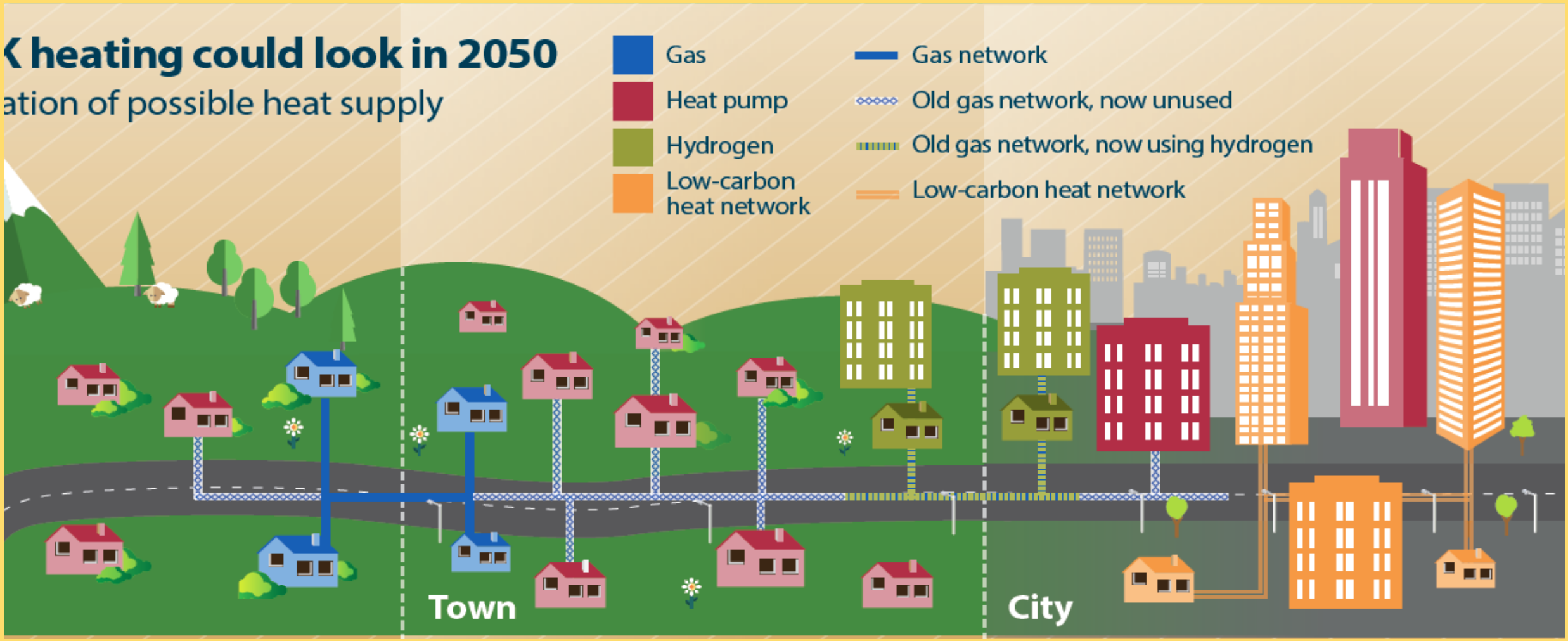
What Is Driving DE Development in UK?

Environmental Drivers

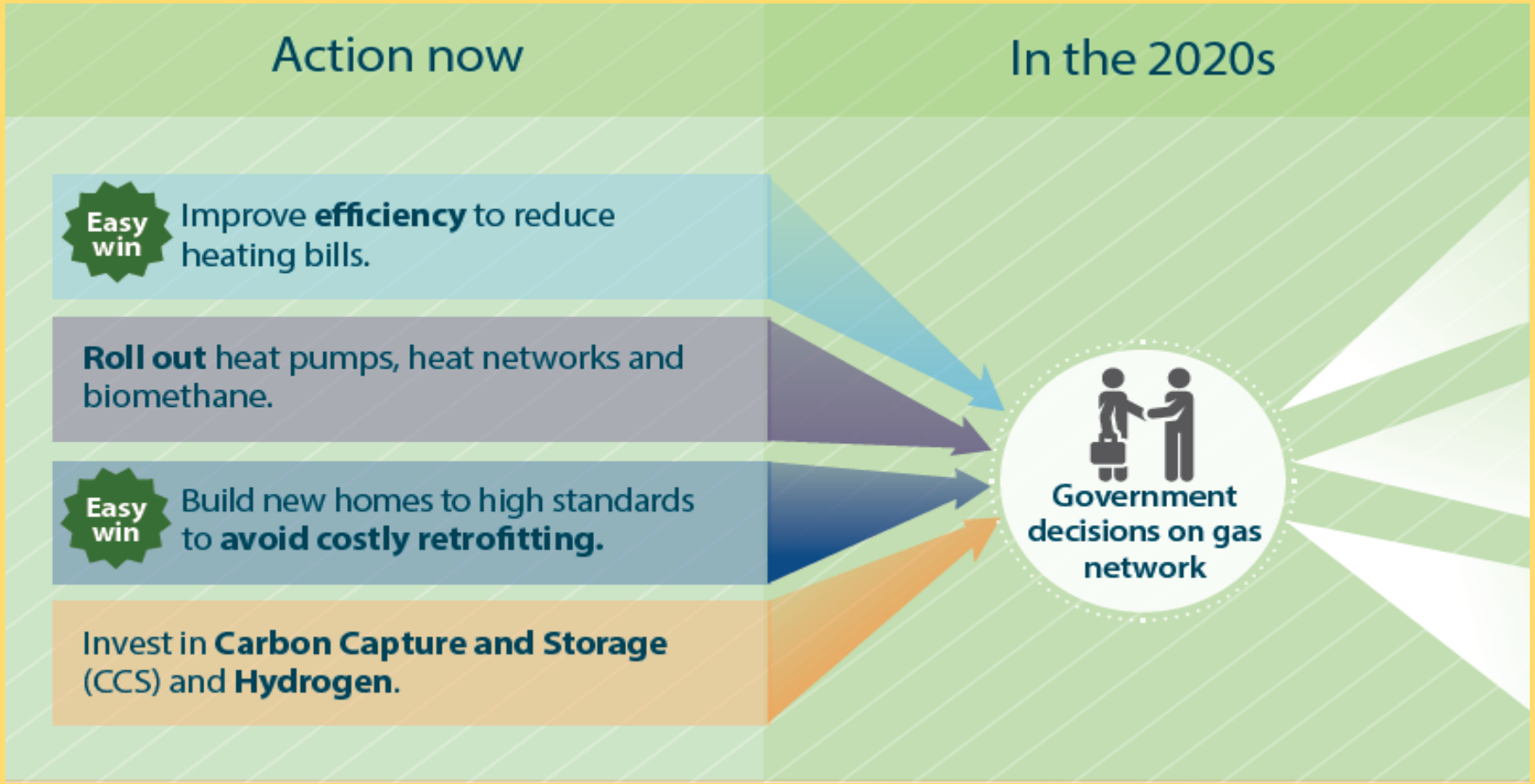
Committee on Climate Change – 5th Budget



- Cannot meet carbon budgets without de-carbonising heat
- Heat networks have an important role to play



Shift from one dominant technology to range of solutions depending on local situation



Getting there requires effective roll-out of each option now.
And associated investment in training, certification and supply chain

England

- Develops policy '*The Future of Heating*' (Mar 2013)
- Key focus on local authorities
- Establishes Heat Network Delivery Unit
  - supports LA's with heat mapping, policy development, early feasibility and techno-economic assessment
- Launches Heat Network Investment Project (Oct 2016)
  - 5 year investment program
  - £320m budget
  - Leveraged estimated total of £2bn
  - Pilot round supported 9 projects with £24m
- Encourages industry to establish consumer protection (Heat Trust)
- Encourages industry to establish guidance on technical standards (CIBSE/ADE Manual)

Scotland

- Develops policy '*Heat Policy Statement*' (2015)
- Target of 1.5TWh demand & 40,000 homes connected
- Establishes Expert Commission on DH to advise Govt
- Establishes District Heating Loan Fund
- Establishes Heat Network Partnership
  - coordinate support for projects with heat
- Launches consultation on regulation of DH (Dec 2016)
  - LA's develop Heat & Energy Efficiency Strategies
  - Used to define district heating zones
  - Licensing system for operators
  - Operators compete for excl concessions in zones
  - Criteria includes affordability & de-carbonization
  - LA's to be given power to obligate connection
  - Industrial operators obliged to provide data on waste heat availability
- Aims for 80% of buildings to be connected to low carbon heat sources by 2032

What Is Driving DE Development in UK?

Environmental Drivers

- EU Directive on Energy Efficiency (2012)
- Requires assessment of national potential for CHP and DHC
- England has potential of 60% of buildings served by DHC
- Scotland has potential for 7% of buildings served by DHC

Economic Drivers

- Government austerity program cuts financial support for local government
- Local authorities driven to investigate opportunities for other revenue sources.
- Interest in DH coincides with availability of financial support from HNIP

Social Drivers

- DH provides opportunity to address fuel poverty
- Incorporated into Committee on Climate Change objectives through ‘trilemma’
- Incorporated into Scottish Govt. proposal on heat regulation