The role of households in the smart grid: A comparative study

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Agenda

- Background – the project and this presentation
- Introducing the smart grid concept and some conceptualisations of the household in the smart grid
- Comparing Norway, Denmark and Spain – energy systems, smart grid R&D and demonstration activities and energy policies
- Implications for the household in the smart grid – and relations to country-specific differences

BACKGROUND

Background and focus

- ERA-Net project "Integrating Households in the Smart Grid"
    - Norway
    - The Basque Country (Spain)
    - Denmark
- Website: www.ihsmag.eu
- Focus of this paper/presentation: How country-specific factors influence the (conceptualisation) of the households' role in the (future) smart grid.
- Based on survey of electricity system characteristics, energy policies and R&D/demonstration projects
   - Literature review and collecting statistical data

INTRODUCING SMART GRIDS AND THE HOUSEHOLDS IN THE SMART GRID

The smart Grid

- *The new catch word within sustainability and energy*

- Integration of information and communication technology
- Balancing production and consumption of energy (renewable energy)
- Increased use of decentralised energy generation (micro-generation)
- Liberalisation of energy systems and markets
- Increased focus on climate change
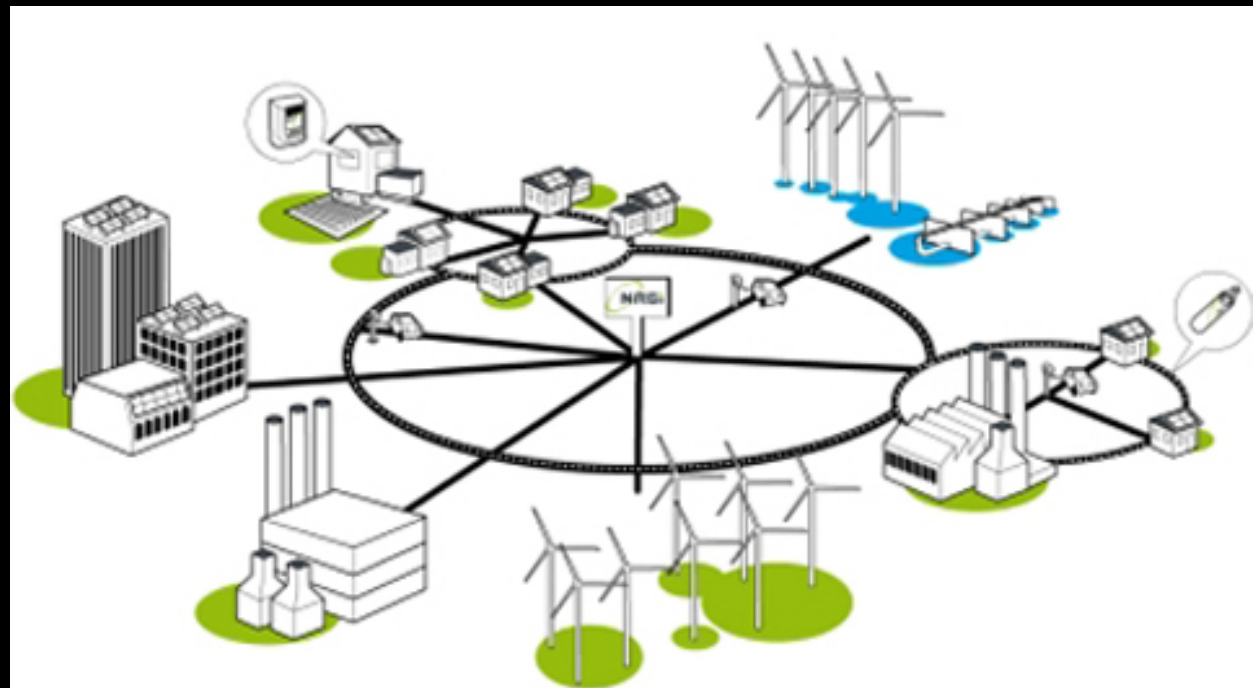
Households' role in the smart grid

- Demand-side management (load management)
- Micro-generation ("prosumers")
- Prize incentives and feedback to consumers

➢ A widespread focus on how to make the households *adopt* new technologies and solutions (including market solutions like dynamic pricing etc.)

➢ Previously, the smart grid development seems to have had a highly technology-centred approach

The perspective of IHSMAG project
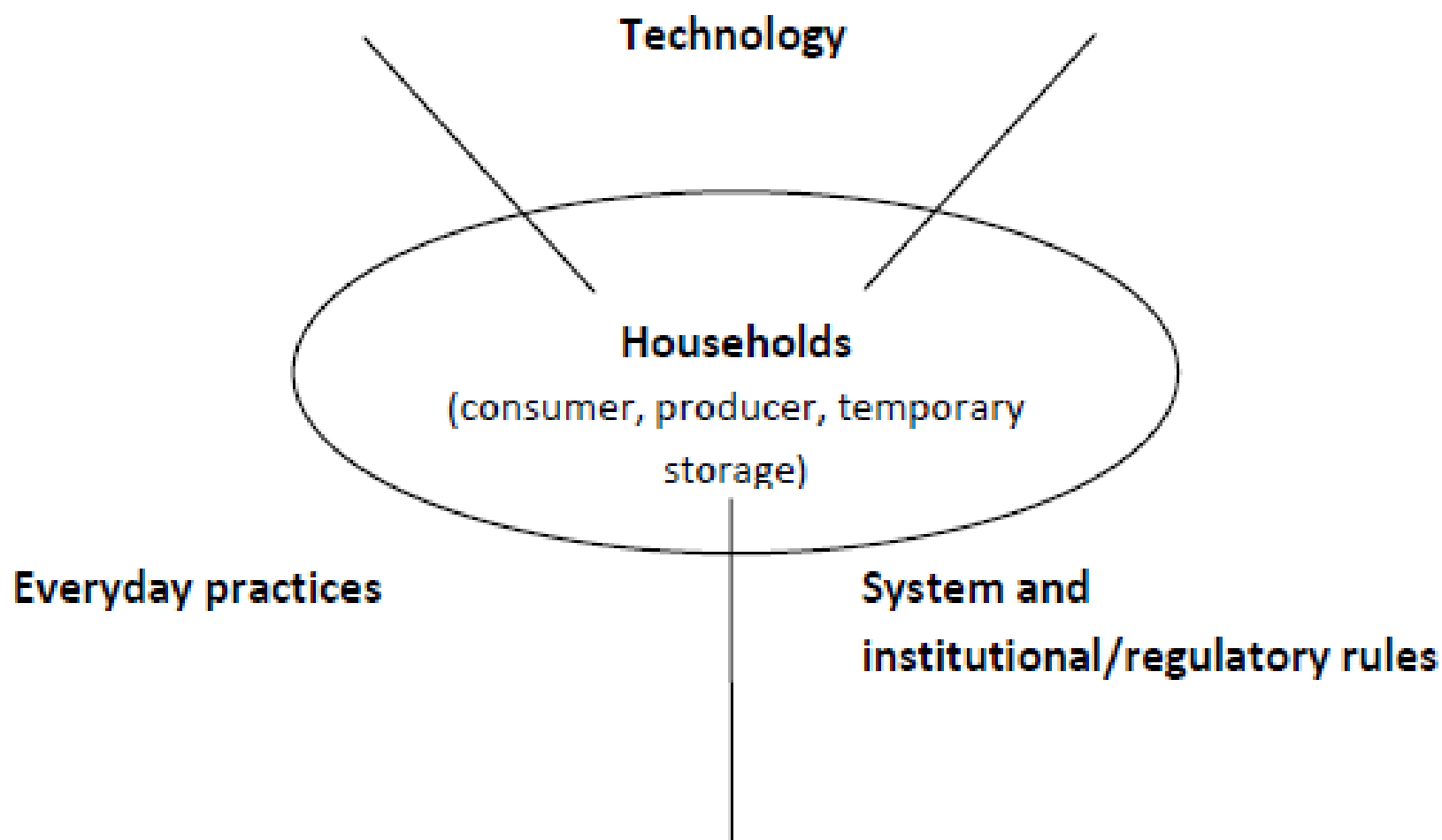
Changing practices

Some practices are more "flexible" for change than others – for instance for time-shifting in relation to demand-side management / load management. Depending on:

- How a practice is integrated into the daily rhythms of the household (the complexes of practices) and its dependency on other practices
  - e.g. Doing laundry >< Preparing the evening meal
- The character of the link between energy use and performing the practice (degree of potential time delay between energy use and performing practice)
  - e.g. Space heating >< Playing computer games
- Symbolic meanings of the practices – and to what extent this involves prescriptions for the *right timing* of its performance
  - e.g. Eating evening meal >< "Doing" Facebook

Load management

Examples of practices that seems relative flexible for load management (final uses):

- Heating
- Cooling (refrigerators/freezers)
- Air conditioning
- Dishwashing (using a dishwasher)
- Laundering

COUNTRY-COMPARISON – NORWAY, SPAIN AND DENMARK

Some key figures

	Spain		Norway		Denmark	
	1990	**2009**	**1990**	**2009**	**1990**	**2009**
Population (millions)	39.0	45.9	4.2	4.8	5.1	5.5
Residential electricity consumption – share of Total Final Consumption of electricity (%)	24	27	31	35	34	32
Electricity share of total final energy consumption within the residential sector (%)	28	40	72	78	21	20
Total Final Consumption of electricity per capita – Residential sector (kWh/capita)	774	1,514	7,214	7,583	1,784	1,836

National energy policies

Denmark

- 34% CO_2 reduction by 2020 (compared to 1990)
- 100% renewable energy system by 2050 (especially wind power + biomass)
- Much focus on smart grid and load management

Spain

- 10% CO_2 reduction by 2020 (compared with 2005)
- Focus on security of supply (renewable energy)
- Increase wind power (=> increasing balance problems)

Norway

- 30% GHG reductions by 2020 (compared with 1990)
- Carbon-neutral by 2050
- Focus on introducing renewable energy in transport and (petroleum) industry
- Norway as Europe's "green battery" (reserve capacity)

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Electricity generation by source
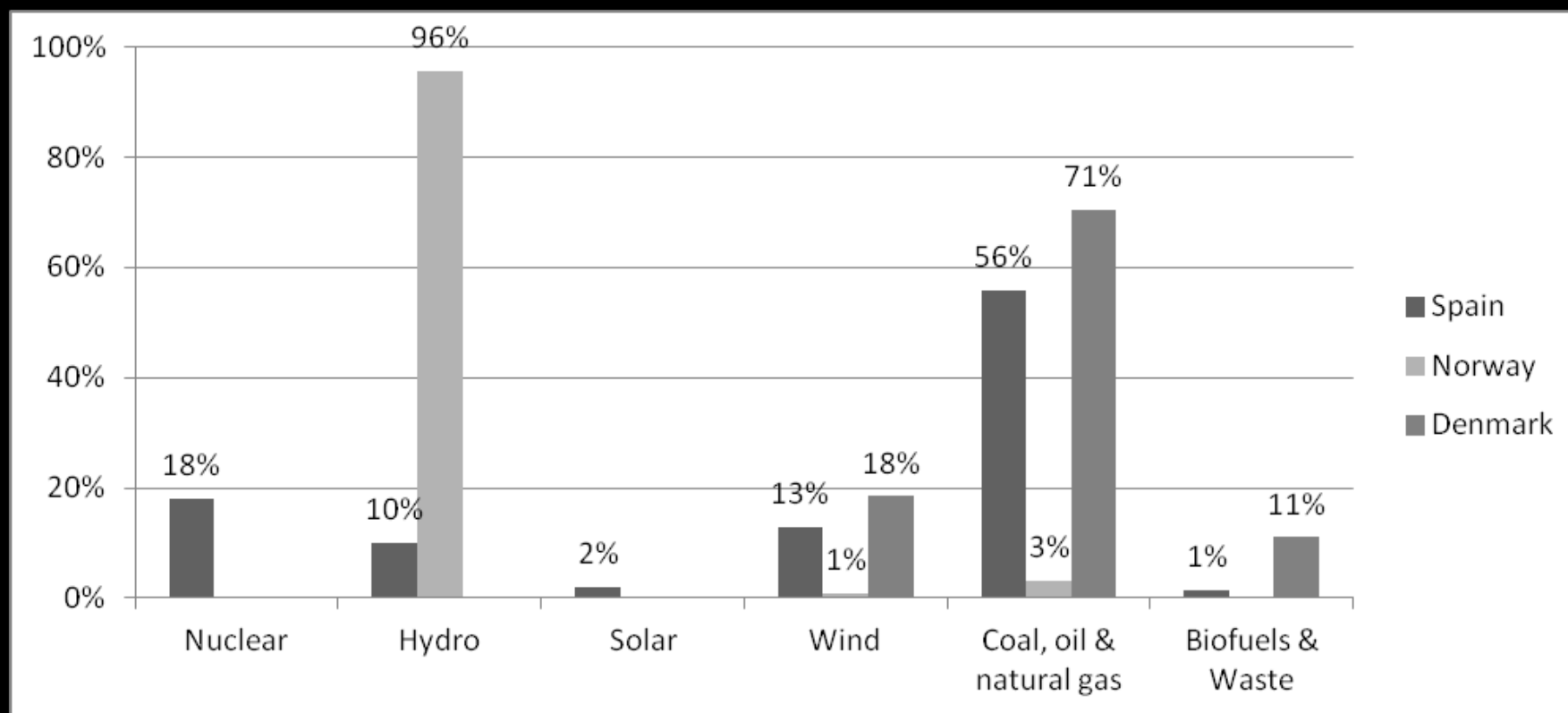
Key characteristics and challenges

Denmark

- Diversified electricity generation
- Balancing generation and consumption (2020-goal of 50% wind power)
- CHP widespread – and with low flexibility in general

Spain

- Diversified electricity generation
- Challenge of peak-consumption following increased use of air-conditioning
- Challenges of balancing generation and consumption (more wind power)

Norway

- Possible grid capacity problems in the future (due to electrification of new sectors – e.g. offshore oil production)
- Highly flexible electricity production (hydro power)

Distribution by final uses (households)

	Denmark (2006)	Norway (2007)	Spain (2007)
Lighting	11%	9%	18%
Heating, cooling and white goods	59%	86%	64%
Cooking	8%	2%	15%
Heating (space and water)	18%	76%	18%
Fridge/freezer	18%	5%	18%
Laundry	15%	3%	10%
Dishwasher	-	-	2%
Air conditioning	-	-	1%
Miscellaneous	30%	5%	18%
TV, video, stereo	12%	-	10%
PC	8%	2%	7%
Other small appliances	10%	3%	1%
Total	100%	100%	100%

Load management potentials

Share of residential electricity consumption that could (potentially / ideally) be subject to load management:
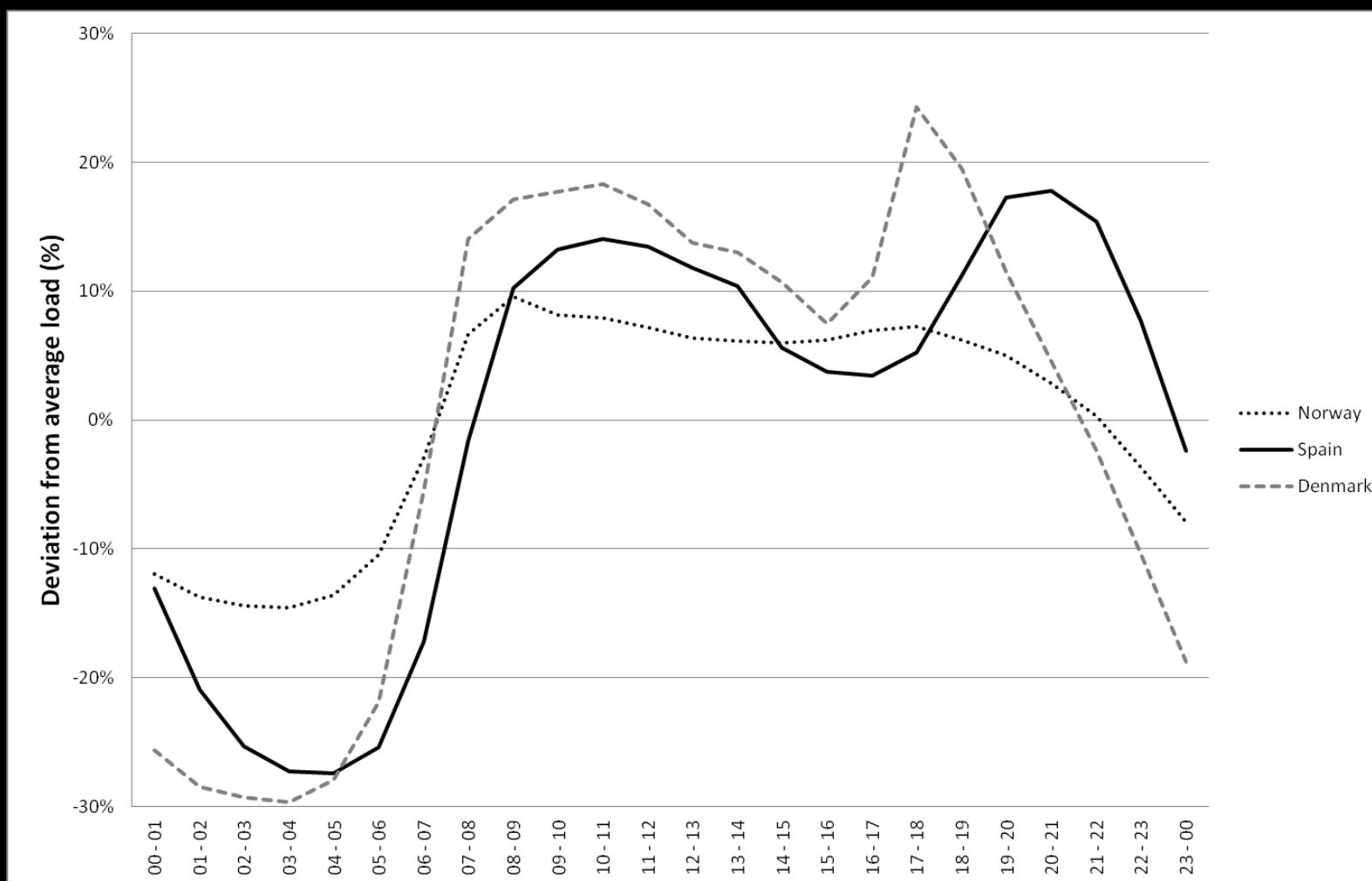
Denmark: 51%
Spain: 49%
Norway: 84%

Final uses: heating, fridge/freezer, laundering, air conditioning and dishwashing

Load profiles – winter

Load profiles for week days in January (23-27 January 2012)

Smart grid R&D and demo projects

	Electricity saving	Load management	Micro-gen.	Other
Heating/air cond.		DK: Price-sensitive electricity cons. in households DK: EcoGrid EU DK: eFlex DK: Intelligent remote control of heat pumps DK: Trials with heat pumps on spot agreements ES: ADDRESS		
Cooling		ES: ADDRESS		
Laundering		ES: ADDRESS		
Cooking				
Lighting & other appliances				
Transport		DK: EDISON DK: EcoGrid EU DK: eFlex DK: Intelligent charge stands DK: Test en elbil ES: MUGIELEC		DK: Test en elbil DK: Better Place DK: Etrans
Household electricity consumption in general (excl. transport)	DK: ConsumerWeb DK: EcoGrid EU DK: Intelligent home DK: EnergyFlexHouse DK: Feedback-motivated energy savings DK: Several "feedback light" solutions in relation to smart meters (provided by DSOs) NO: Demo Steinkjer NO: Smart Energy Hvaler ES: Smart City Malaga ES: BIDELEK	DK: eFlex DK: iPower DK: Energy Forecast DK: FlexPower DK: EnergyFlexHouse NO: Demo Steinkjer NO: Smart Energy Hvaler ES: Smart City Malaga ES: PROYECTO GAD ES: BIDELEK	DK: EnergyFlexHouse NO: Smart Energy Hvaler	DK: IMPROSUME NO: Demo Lyse
Other				DK: Innovation Fur

COUNTRY-SPECIFIC FACTORS – IMPLICATIONS FOR THE ROLE OF HOUSEHOLDS IN THE SMART GRID

Concluding points...

- Load management in focus in all countries – but particularly in Denmark (50% wind power by 2020)
- Norway has the smallest challenges in relation to consumption peaks and fluctuations – but at the same time the most "flexible" electricity generation (hydro power)
- Focus on promoting electrification of energy consumption previously based on liquid fuels (oil) in all countries (de-carbonization)
  - Particularly heating (DK) and person transport (all countries)

The role of the households

- Investing in new technologies (micro-generation)
- Changing energy consuming practices ("behaviour change")
- Adopting new technologies that replace previous high-carbon technologies
  - E.g. EVs instead of internal combustion engine cars
- Accepting new technologies that can manage their electricity consumption (often "automated")
  - Load management
  - Energy savings (e.g. home automation)

➢ General shift in focus from energy efficiency to load management and micro-generation (prosumers)

Household conceptualizations

Dominant conceptualizations of the consumer/household:

- Motivating households to *change* their daily practices through information (feedback) and price incentives (the "rational and worried" agent or "homo economicus")
    - E.g. dynamic real-time pricing
- *As little involvement* of households as possible – "hidden solutions" ("homo convenience")
    - E.g. automated remote management of appliances

➢ Critique: Both approaches are rather limited in the understanding of households – and leave very little (no) room for other kind of involvement of households

THANK YOU FOR YOUR ATTENTION

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