UNEP Global Outlook on Methane Gas Hydrates

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Semi-Annual Report

Frozen Heat: A Global Outlook on Methane Gas Hydrates

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ADMINISTRATIVE SUMMARY

The UNEP Global Outlook on Methane Gas Hydrates project has received funding from the US Department of Energy under award number DE-FE0003060. The project director is Yannick Beaudoin and the recipient institution is Stiftelsen GRID-Arendal in Arendal, Norway.

The current report is for the period starting April 1, 2010 and ending September 30, 2011.

EXECUTIVE SUMMARY

The UNEP Global Outlook on Methane Gas Hydrates seeks to provide policy makers, the general public and the media with a synthesis of aspects of natural, social and applied sciences that relate to this type of natural gas occurrence. With an emphasis on visual media, the Outlook is working to define global methane gas hydrate occurrences in their natural settings and examine the implications on communities and society of the potential use of methane gas hydrates as an energy source.

During the time period covered by the current report, the UNEP Global Outlook on Methane Gas Hydrates has pursued efforts to complete the next major project milestone, the production of a final content draft as per Task 5.0 of the main DOE project structure document (SOPO). Delays in content development are linked to a request for additional time by the various international expert workgroups to ensure product quality. The delay in progress is thus deemed justified. Task 5.0 is expected to be completed by end of December 2011 (see Table 2).

An additional item developed and implemented pertains to an greatly improved project web portal aimed at providing the general public with informative multimedia material lined to methane hydrates.

DISCUSSION

Methodology

The Global Outlook on Methane Gas Hydrates to be produced by bringing together leading international experts from academia, business, governments and intergovernmental and non-governmental organizations selected from throughout the world. Guided by a Steering Committee of scientific and technical experts the Global Outlook on Methane Gas Hydrates will provide unbiased, credible and science based information. Where consensus in the expert community is unclear, debates and uncertainties will be highlighted and needs for new and/or continued research identified.
The drafting of the report involves teams of experts according to the key themes to be addressed. Each chapter will be subject to peer review, which will inform and broaden the editorial process. As a follow up to the Outlook, discussion, consultations and bi- and multilateral outreach initiatives will serve to disseminate the content, encourage dialogue and assist in incorporating key perspectives into policy development.

Thematic Outline

As discussed an agreed upon by the project Steering Committee, the UNEP Global Outlook on Methane Gas Hydrates will be divided into two volumes and expand on key themes deemed of importance to policy makers, industry and society.
Volume 1 examines the settings and roles of methane gas hydrates in the natural system. It begins (chapter 1) with an examination of the history of hydrate science and a basic definition of methane gas hydrates including: molecular, chemical and physical characteristics, occurrence types and their geological settings and a brief overview of the sources of methane that lead to the formation of methane hydrates. The chapter continues with a qualitative examination of global methane gas hydrate occurrences aimed at providing an overview of their global distribution by type and also of the inherent uncertainties linked to the published estimates. This section is meant to provide both a sense of scale but also to properly discriminate between the various global methane reservoirs.
The next section in the volume (Chapter 2) expands on the role of methane gas hydrates in the natural carbon cycle. A more detailed overview of the natural sources of methane (e.g. biogenic and thermogenic) will be provided including a summary of the global methane budget. Various physical processes that regulate natural methane emissions will be examined in addition to a discussion on the time scales of natural variations in gas hydrate occurrences. Examples from the past will be used to illustrate these natural variations and include: negative carbon excursions in the geological past and the role of hydrates in global transition from ice ages to warm periods. Finally, seafloor and terrestrial geomorphological issues will be discussed including slope slides in the marine/lacustrine settings and the reshaping of the ground surface in permafrost settings. Chapter 2 will also discuss chemosynthetic ecosystems that are dependant on near surface methane emissions and how these emissions may be linked to deeper methane gas hydrates occurrences. It will present the various biological processes that regulate natural methane emissions in particular in the marine/lacustrine environment. The sensitivities of the methane consuming ecosystems to natural climate and geological variations will form an integral part of this chapter.
The final section (Chapter 3) of Volume 1 will contain visual models depicting various scenarios of natural global warming and the associated impacts on global methane gas hydrate reservoirs. This is meant to provide a baseline of sensitivity for discussions related to the anthropogenic amplification of climate variability leading to global warming.

Volume 2 changes focus from natural systems to the examination of the human dimensions of methane gas hydrates ranging from key technological aspects related to methane gas hydrates as a potential large scale source of natural gas, to the development of new/sustainable economics models related to potential development, to the various societal and environmental issues surrounding their possible exploitation. The volume begins (Chapter 1) with an ambitious overview of global energy resource efficiency challenges that lead to the key drivers associated with possible methane gas hydrates extraction. These challenges include geopolitical considerations (e.g. regionalization of energy supply), the climate and energy debate, resource scarcity and global growth in energy consumption (i.e. linked to trends in population growth). Models will be used to present scenarios of the impacts (e.g. on global greenhouse gas emissions) of altering the global energy picture towards a more natural gas based economy while integrating and implementing a strategy for de-carbonising the global energy system. From a geopolitical perspective,

the possible ramifications of the availability of a large scale energy source that is more globally distributed will de discussed. The environmental and social footprint of potential methane gas hydrates will also be examined in comparison to other non-conventional natural gas sources such as shale gas. Resource valuation taking into consideration ecosystem services (i.e. natural capital) will be proposed as a more realistic and holistic methodology when planning for development. Finally, the main headers of a new/sustainable economics-based business model will be developed and provided as a template for possible future resource development.

Chapter 2 details the technological considerations for the exploration side of possible methane gas hydrates development. An initial definition of the types of methane gas hydrate occurrences that could potentially be developed using existing technologies is followed by a synthesis of the methods used to detect and define these occurrences. Examples of actual real world site that have been technically defined will be used for illustration purposes.

Following the examination of exploration and delineation, the next section (Chapter 3) will detail the technologies and challenges linked to the production of natural gas from methane gas hydrates. An investigation of the recovery approaches using adapted conventional technologies will focus on key elements of the production cycle including accessing the reservoir, dissociation techniques and the requirements for achieving long term production. Disassociation techniques for methane gas hydrates include both methods that can make us of existing technology (e.g. pressure reduction) and those that require additional research and development (e.g. temperature, chemical and mechanical stimulation; CO_2 injection; kinetic inhibitors). Unique technical challenges linked to production include the management of water as a bi-product, sand production and gas leakage. This section will then address the broader environmental impacts of methane gas hydrates development based on various scenarios. Examples of impacts include: possible methane release to the atmosphere and/or hydrosphere; possible impacts on methane-based ecosystems; marine slope stability; impacts on surface morphology (i.e. in permafrost settings).

The following section (Chapter 4) addresses societal perspectives related to energy resource development. As resource development impacts society from the national to local community scale, this section seeks to illustrate various perceptions linked to energy resource development in order to help shape policies relating to potential future methane gas hydrate development. Areas with previous experience with conventional oil and gas development will provide guidance with respect to concerns related to development, the benefits on well-being of development and practical suggestions to improve the polices linked to potential future development. As occurrences of methane gas hydrates are more globally distributed, many areas with no previous experience with traditional oil and gas development may be affected by methane gas hydrates development. The advice provided in this section will be aimed at ensuring that these previously unaffected areas take into consideration the experiences of others. Case studies from areas including the Arctic region (local community scale) and countries like Japan and India (national scale having not experienced large scale traditional oil and gas development) will be used to illustrate different realities linked to energy resource development.

The final section of volume 2 (Chapter 5) will seek to summarize the main points emphasized in the entire Outlook into the context of sound policy making. Challenges, opportunities, policy responses and options will be provided for stakeholders from government, the private sector, community leaders and the general public in a broad wrap up of the key messages and discussions contained in the Outlook. This section will also examine past experiences in relation to policy issues and how these can be improved upon to shift away from unsustainable practices in global energy resource use towards the most sustainable development possible of non-renewable,

finite resources. A development model for methane gas hydrates based on the conversion of financial revenue to new forms of capital (e.g. social capital in the form of national wealth sharing funds; natural capital in the form of revenue diversion towards the longer term need to develop renewable energy sources to replace exhausted hydrocarbon reserves) will be expanded upon to provide both government and industry leaders with new management and policy options.

Public outreach, multi-media site and global gas hydrate spatial explorer and Wiki-base

This public outreach web-portal, found at www.methanegashydrates.org aims to: 1) keep to provide an interested public with a multimedia experience of gas hydrates and gas hydrates research and 2) establish a non technical geospatial knowledge base of global gas hydrates research sites and occurrences. The site has already been profiled on the main UNEP web portal with further targeted advertising planned. (see screen shot of front page of web portal).

Concluding remarks

Despite some delay in completing the vetted content development, the general consensus is that the progress of the UNEP Global Outlook on Methane Gas Hydrates remains good. The strength of the international scientific and multi-stakeholder partnership continues to allow for an efficient development of the work with a strong focus on quality control. The UNEP Global Outlook on Methane Gas Hydrates is on target to achieve its primary goal of mainstream knowledge and information on the latest developments in the methane gas hydrates research community.

Table 1: Cost Plan/Status Report

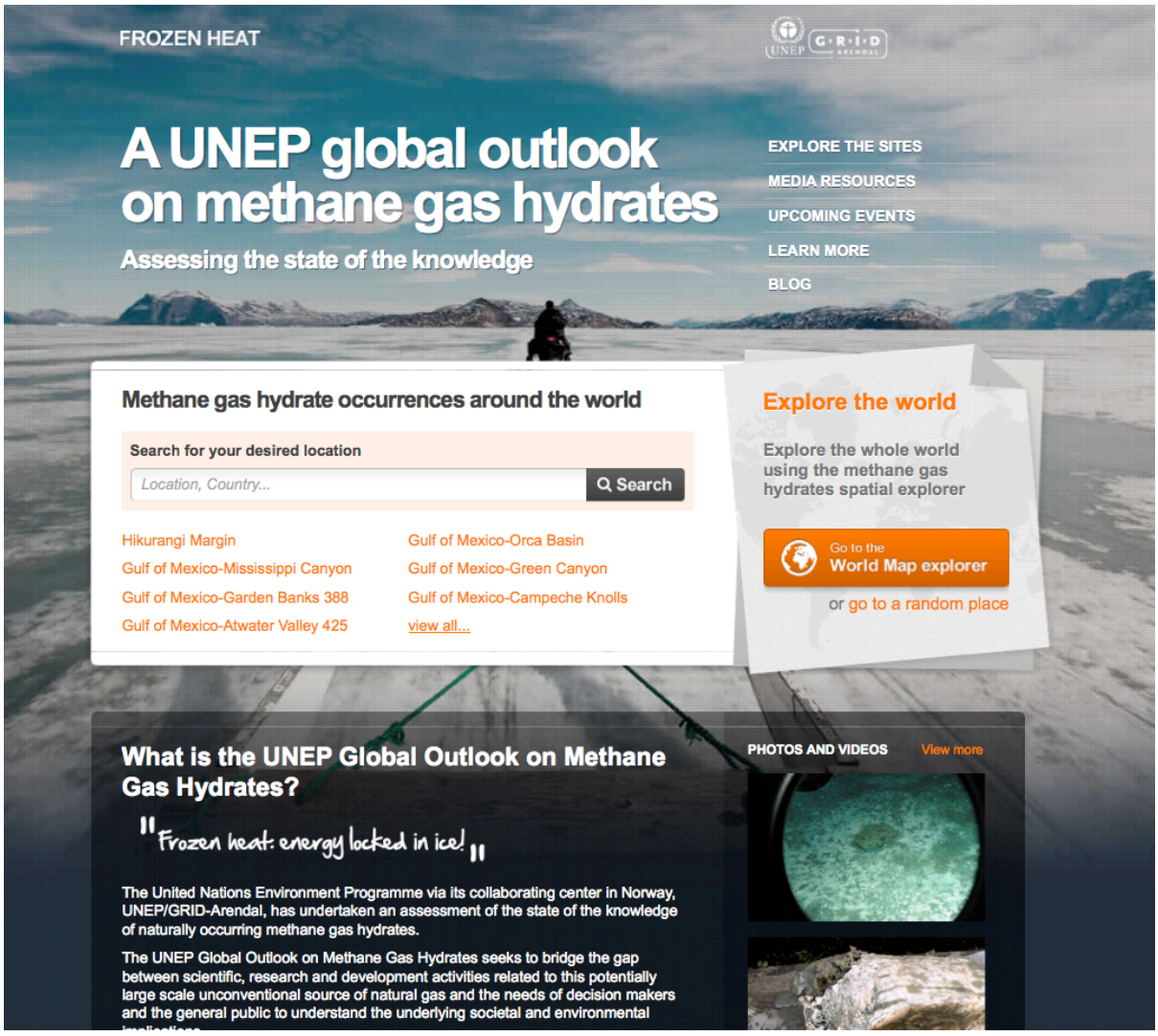
Task/Subtask #	Project Duration Start March 1 2010 End May 31 2012										
	Project Year 1 (1 Apr-30 Sept 2010)				PY2 (01 Oct - 31 May)						
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q5	Q6	Q7
Baseline Cost Plan											
Federal Share		$50 000			$50 000						
Non-Federal Share	$65 000		$45 000		$10 000	$10 000	$10 000	$55 000	$10 000	$85 000	$10 000
Total Planned (Federal and Non-Federal)	$65 000	$50 000	$45 000	$0	$60 000	$10 000	$10 000	$55 000	$10 000	$85 000	$10 000
Cummulative Baseline Costs	$65 000	$115 000	$160 000	$160 000	$220 000	$230 000	$240 000	$295 000	$305 000	$390 000	$400 000
Actual Incurred Costs											
Federal Share		$47 475	$2 525				$36 307				
Non-Federal Share	$61 630		$39 855	$30 148	$6 802	$21 995					
Total incurred Costs-Quarterly (Federal and non-Federal Share	$61 630	$47 475	$42 380	$30 148	$6 802	$21 995	$36 307	$0	$0	$0	$0
Cumulative Incurred Costs	$61 630	$109 105	$151 485	$181 633	$188 435	$210 430	$246 737	$246 737	$246 737	$246 737	$246 737
Variance											
Federal Share	0	$2 525	0	$0	$50 000	$0	($36 307)				
Non-Federal Share	$3 370	$0	$2 620	($30 148)	$3 198	($11 995)	$10 000	$55 000	$10 000	$85 000	$10 000
Total Variance-Quarterly (Federal and non-Federal)	$3 370	$2 525	$2 620	($30 148)	$53 198	($11 995)	($26 307)	$55 000	$10 000	$85 000	$10 000
Cummulative Variance	$3 370	$5 895	$8 515	($21 633)	$31 565	$19 570	($6 737)	$48 263	$58 263	$143 263	$153 263

Table 2: Milestone Status Report

Task/Subtask #	**Project Milestone Description**	**Project Duration Start March 1 2010 End March 1 2012**							
		Project Year 1				**PY2**			
		Q1	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**
Task 1.0	Project Infrastructure Development		completed						
subtask 1.1	Project Website Development		completed						
subtask 1.2	Virtual Office Development		completed						
subtask 1.3	Project Steering Committee	completed							
Task 2.0	Development/Approuval of Assessment Work Plan and Guidelines		completed						
Task 3.0	Establishement of Content Development Teams			completed					
Task 4.0	Draft Assessment Content Development and Vetting				draft 0 completed				
Task 5.0	Final Assessment Content Development and Vetting					in progress			

APPENDIX

Screen capture of improved project website:



APPENDIX I: Meeting report of third Steering Committee Meeting, July 22, 2011

UNEP GLOBAL OUTLOOK ON METHANE GAS HYDRATES

Edinburgh Meeting Report

UNEP GRID ARENDAL
Environmental Knowledge for Change

Edinburgh work session

July 22, 2011

Acknowledgments

As coordinating institution for the UNEP Global Outlook on Methane Hydrates, UNEP/GRID-Arendal would like to extend special thanks to Herriot-Watt University for their assistance in the organisation of the meeting. UNEP/GRID-Arendal would also like to thank the respective organizations of the meeting participants for special allowances made to extend time spent in Edinburgh in support of this project.

Background for Work Session

With the deadline for the start of production (i.e. graphics, design, layout) set for Fall 2011, there is an imminent need to conclude the content production phase of the projects. With all chapter drafts now received, the full (pre-edit) first drafts of Book 1 and 2 are now accessible providing all chapter leads with a more complete overview of the content.

The expected attrition and prioritization phase of content development is now ready to begin to reach the milestone of a first official Book 1 and 2 draft within the chapter page limits imposed on by the project (see Table 1 below). Attrition and scaling down of content is primarily linked to 1) financial constraints linked to production and 2) the inherent limit in value of a product that is too bulky. Guiding principles for attrition and trimming of content include:

- Highlight and prioritization of content specific to gas hydrates with referencing of other sources linked to broader but relevant themes
- Ensuring no overlap or duplication of content
- Transformation, where possible, of textual explanation into a graphical product that may be able to explain a number of issues thus cutting back on the need for text
- Relegating links to more in depth material for the e-book version of the publication

To facilitate this process, the project coordinator proposes to assign two Book Coordinators to work with Chapter Leads within the context of addressing the development of the full narrative of each book.

WORKSHOP GOALS

1) To examine the available chapter drafts and discuss content issues (i.e. overlap, missing elements, chapter organisation)
2) To develop and action plan to lead to a final Book 1 and 2 pre-edit draft within the page limits imposed by the projects
3) To examine the new hydrates public outreach web portal and finalise feedback for launch

PROPOSED ACTION PLAN (TO BE MADE FINAL FOLLOWING A FEEDBACK ROUND WITH ENTIRE STEERING COMMITTEE):

1-produce final book drafts based on page allocations

- Book Content Coordinator assigned
- Organize book
- Produce guidance list to be used by specific external authors invited by Chapter Leads to contribute/substantively review specific themes in Chapters; goal is to expand author base (with an emphasis on geographic criteria to avoid dominance by one region whenever possible)
- All chapter leads to comment/review full book
- Deadline for complete Book 1 (pre-edit) draft: Sept 15

Book 1 specifics:

- Book 1 Content Coordinator : Bill Waite
- Scale down to page limits (Table 1) and homogenize chapters
- Chapter 2-3: aggregate in accordance to prioritization needs for page reduction and focus provided in current work session discussions (see below) (aggregation to be led by Kelly Rose and Tina Treude)
- Chapter 4 to be condensed, as led by Scott Dallimore and Klaus Wallman, likely with an external contributor.

Book 2 specifics:

- Book 2 Content Coordinator : Scott Dallimore
- Scale down and homogenize chapters
- Chapters 1 and 4 to be scaled down and edited for tone and structure (feedback and comments to be provided by StComm)
- Chapter 2 to be strengthened (effort to be coordinated by Ray Boswell, Yoshihiro Nakatsuka and Tatsuo Saeki);
- Chapter 3: some re-structuring; add production related geohazards with support from Craig Shipp
- Deadline for complete Book 2 (pre-edit) draft: Sept 15

2-external substantive review of books encouraging "reviewers" to agree to be listed as contributors in parallel to review by full steering committee (mid-September to mid-October)

EXPANDED MEETING NOTES:

Book 1 proposed final structure: 85 A4 pages including text, textboxes and visuals = approximately 265 pages in laid out format). Chapter requirements; for consistency in structure and flow, each chapter should start off with an outline of the goals of the chapter.

Introduction (5 pages)

Chapter 1 consolidated to 20-25 pages A4 including text, textboxes and visuals (not including references list)

Some elements to be moved to Book intro

Add chapter goals and purpose

Mention the importance (or current lack thereof) of BSRs in searching for hydrates.

Consolidation of Chap 2 and 3 aggregated and consolidated to 20-25 pages A4 including text, textboxes and visuals (not including references list):

Hydrates in the context of natural cycles:

Carbon cycle to methane cycle to role of hydrates

Biologic contribution to carbon/methane cycling, with priority on hydrate related ecosystem with referencing to work on broader methanotrophic organisms

Missing element: geomorphological effects

Purge all future looking content (to be dealt with in finalized Chapter 4), drawing examples instead from past climate events.

Former chapter 4 : Climate Cycle (20-25 pages)

Chapter 4 to be adjusted after comments by steering committee reviewers; additional recommend effort to include other climate change researchers. One suggestion made was to send text to Carolyn Ruppel who has apparently just written a review of gas hydrates and climate change for Nature. Scott Dallimore to talk with Klaus about this idea.

Focus on future looking "scenarios"

Summary chapter (5 pages A4 including text, textboxes and visuals)

** addressing natural geohazards and hydrates in Book 1: catastrophic release, slope stability (Craig Shipp)

Book 2 proposed final structure: 100 A4 pages including text, textboxes and visuals = approximately 300 pages in laid out format). Chapter requirements; for consistency in structure and flow, each chapter should start off with an outline of the goals of the chapter.

Introduction (5 pages)

Drivers well spelled out; possibly move from Chapter 1 to Introduction

Chapter 1 25 pages A4 including text, textboxes and visuals (not including references list) Anne Solgaard to coordinate finalization:

Consolidation: Highlight "policy" needs related to ensuring possibility of hydrates as an option to the energy mix

Special notes: add in intro to chapter:

- Context of origin of the 3 scenarios at forefront
- Add comment linking the use of 3 scenarios as applied to possible hydrates development
- Lead off to other chapters in book: i.e. in order to have hydrates as a future resource option adding to natural gas "reserves", certain conditions need to be met (and included in sound policy making)…these conditions will be examined in this book…etc

Chapter 2 10-15 pages A4 including text, textboxes and visuals (not including references list) Ray Boswell and Yoshihiro Nakatsuka to further develop and finalize:

Expand and properly explain terms such what constitutes a "resource"

Global context for where potential "resources" are located

What are the most prospective sites

Elements missing: Exploration methods and techniques

"Case studies"… Nankai, Mallik?, North Slope Alaska? India/South Korea (model systems for fine-grained reservoirs)

Chapter 3 25 pages A4 including text, textboxes and visuals (not including references list)

Add some context of hydrates as geohazard to conventional deep water oil gas exploration; Production related geohazards (support from Craig Shipp)

Chapter 4 25-30 pages A4 including text, textboxes and visuals (not including references list); Anne Solgaard to coordinate finalization of chapter

Priority: Language…re-write in neutral tone

Ensure a more global context…referring less to West Africa

- Extract principles from Paul's writing and keep them global rather than identified with specific area.
- Highlight more specific links to hydrates
- The two suggested concepts below will likely differ between locations in which gas infrastructure is in place, and locations with no such infrastructure. How the chapter is parsed is perhaps a matter of style, but one proposal would be:
    - – starting with the premise that hydrate extraction is basically similar to natural gas extraction, tools and practices relevant for locations with existing gas infrastructure could be suggested, and then separately suggest tools and practices for locations with no gas infrastructure. A benefit of this approach is that a policy manager scanning the book can quickly drop in on the relevant text based on their own situation rather than sifting through the two suggested concepts below to see which are relevant for their case. Under this proposal, the two concepts below would be folded into both the infrastructure and non-infrastructure sections.
- Emphasize development of policy and regulatory regimes that would be needed for successful management of hydrate development (e.g. revenue streams)
- Emphasize early phase of local education and participation in decision making to ensure ownership of process (including benefits sharing) at all levels

“Case Study” proposal: possibly reference the recommendations of the Canadian Council of Academics report as an example of a “national hydrates strategy”.

Chapter 5 5-10 pages A4 including text, textboxes and visuals (not including references list)

Challenges, opportunities, policy perspectives, knowledge gaps

Content from all Book 1 and 2 chapters to be synthesized in contents of highlights for policy makers

Table 1: guidelines for final page allocations for Book 1 and 2 Chapters.

CHAPTER		CURRENT DRAFT 1 A4	LAYOUT ALLOWANCE A4	
Book 1			90-100	**270-300 LAID OUT**
Introduction			5	
1		27 text (18 graphs 1 per page)	20 (pages text + space allocation for final graphs)	
2-3		68	25-30	
4		26	20-25	
Conclusion			5	
Book 2			90-100	**270-300 LAID OUT**
Introduction			5	**extra for references**
1		35	25	
2		14	10-15	
3		28	25	
4		38	25-30	
5			5-10	

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