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Цель практикума – овладение студентами умениями и навыками перевода научно-технической литературы по специальности.

Практикум составлен на основе работ В.В. Алимова, И.С. Алексеевой, Е.В. Бреус, Т.А. Казаковой, В.В. Кирилловой, Б.Н. Климзо, Г.Д. Орловой, Р.Ф. Прониной, Г.В. Тереховой, В.С. Слепович, Н.К. Яшиной. Материалы сокращены и адаптированы в учебно-методических целях в соответствии с рабочей программой по дисциплине «Иностранный язык (технический перевод)».

Практикум по дисциплине «Иностранный язык (технический перевод)» предназначен для проведения практических занятий и самостоятельной работы студентов магистратуры, обучающихся по направлению подготовки: 13.04.01 Теплоэнергетика и теплотехника (профиль: Технология производства электрической и тепловой энергии).

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ВВЕДЕНИЕ

Настоящий практикум по дисциплине «Иностранный язык (технический перевод)» предназначен для проведения практических занятий и самостоятельной работы магистрантов, обучающихся по направлениям подготовки: 13.04.01 Теплоэнергетика и теплотехника (профиль: Технология производства электрической и тепловой энергии)

Цель практикума – овладение обучающимися умениями и навыками перевода научно-технической литературы по специальности и формирование компетенций, позволяющих решать задачи межличностного, межкультурного и профессионального взаимодействия.

Практикум позволяет решить следующие задачи:

1) сформировать представление об особенностях языка научно-технической литературы;
2) сформировать представление о лексических, грамматических и стилистических особенностях перевода научно-технической литературы;
3) сформировать умения и навыки, необходимые для перевода научно-технической литературы с английского языка на русский.

Необходимость решения вышеперечисленных задач определяет структуру практикума, которая соответствует рабочей программе дисциплины «Иностранный язык (технический перевод)».

Практикум состоит из 3 глав, рассматривающих теоретические и практические аспекты научно-технического перевода, лексические и грамматические трансформации. Имеется приложение, содержащее информацию, необходимую для технического перевода, и глоссарий основных переводческих терминов. Практикум рекомендуется для аудиторной и самостоятельной работы магистрантов.

Данный практикум составлен на основе работ В.В. Алимова, И.С. Алексеевой, Е.В. Бреус, Т.А. Казаковой, В.В. Кирилловой, Б.Н. Климзо, Г.Д. Орловой, Р.Ф. Прониной, Г.В. Тереховой, В.С. Слепович, Н.К. Яшиной. Материалы сокращены и адаптированы в учебно-методических целях в соответствии с рабочей программой по дисциплине «Иностранный язык (технический перевод)».

1. ОСОБЕННОСТИ ТЕХНИЧЕСКОГО ПЕРЕВОДА

Технический перевод – это перевод, используемый для обмена специальной научно-технической информацией между людьми, говорящими на разных языках.

К ***научно-технической литературе*** относятся следующие виды текстов:

1) собственно научно-техническая литература, т.е. монографии, сборники и статьи по различным проблемам технических наук;

2) учебная литература по техническим наукам (учебники, руководства, справочники);

3) техническая и товаросопроводительная документация (паспорта, технические описания, инструкции по эксплуатации и ремонту, основные технические данные и др.; накладные, упаковочные талоны, комплектовка и др.);

4) техническая реклама: рекламные объявления, фирменные каталоги, проспекты;

5) проектная документация: проекты, расчеты, чертежи;

6) патенты.

Все жанры научно-технической литературы имеют свои ***языковые особенности***. Однако по своему содержанию научно-техническая литература ориентирована на узкий круг людей, т.е. рассчитана на специалиста в данной отрасли знаний.

Для языка научно-технической литературы характерно отсутствие эмоциональной насыщенности, образных сравнений, метафор, элементов юмора, иронии и т.п.

Хотя основной особенностью языка научно-технической литературы является огромное количество специальных ***терминов***, он включает большой процент общеупотребительных слов и словосочетаний. Значительную часть общеупотребительных слов составляют ***многозначные слова***, представляющие известную трудность при переводе. Полисемантизм вообще характерен для английского языка, и нужно всегда иметь в виду, что любое, казалось бы знакомое, слово в зависимости от контекста может иметь совсем иное значение.

Контекст – синтаксический и лексический, узкий и широкий – служит тем средством, которое снимает у многозначной единицы все её значения, кроме одного. В этом заключается его функция. При переводе многозначных слов следует учитывать их грамматические и лексические связи в предложении

Научно-технический перевод требует хорошего знания языка перевода и оригинала. Поскольку научно-технический перевод связан с определенной областью науки и техники, он требует хорошего знания предмета, описываемого в оригинале, а также знания методики и техники перевода.

Иными словами для качественного научно-технического перевода необходимо:

1) знать хотя бы один иностранный язык в степени, достаточной для понимания;

2) знать другой язык (обычно родной) в степени, достаточной для грамотного изложения;

3) уметь пользоваться рабочими источниками информации;

4) уметь делать различные виды технического перевода;

5) обладать терминологическим минимумом;

6) обладать основами информационных компьютерных технологий, работать в режиме текстовых редакторов.

Основные требования, которым должен удовлетворять перевод:

- точная передача текста оригинала;
- строгая ясность изложения смысла при максимально сжатой и лаконичной форме, присущей стилю русской научно-технической литературы.

2. ТРАНСФОРМАЦИИ В ПРОЦЕССЕ ПЕРЕВОДА

При переводе с русского языка происходит множество переводческих преобразований, причина которых чаще всего кроется в присущем английскому языку видении мира и связанном с этим явлении языковой избирательности. Описывая предметную ситуацию, английский язык может выбрать иную, чем русский, отправную точку в описании. Для него, в частности, характерно преимущественное использование глагольных форм. Русскому языку, наоборот, свойственно более широкое использование опредмеченных действий и признаков, что проявляется в более частом, чем в английском, использовании существительных.

Главная цель перевода - достижение адекватности. Адекватный, или как его еще называют, эквивалентный перевод - это такой перевод, который осуществляется на уровне, необходимом и достаточном для передачи неизменного плана содержания при соблюдении соответствующего плана выражения, т.е. норм переводящего языка.

Структурные и лексико-семантические расхождения между двумя языками требуют при переводе с одного языка на другой перестройки синтаксической структуры предложения либо лексической замены английского слова, не имеющего эквивалента в русском языке. Для достижения адекватности перевода применяют различные трансформации, т.е. преобразования, превращения. Каждый случай неэквивалентности структур требует определенной трансформации, которая обычно рассматривается как трудность перевода. Основная задача переводчика при достижении адекватности - умело произвести различные переводческие трансформации, для того чтобы текст перевода как можно более точно передавал всю информацию, заключенную в тексте оригинала, при соблюдении соответствующих норм переводящего языка.

Типы трансформаций в процессе перевода:

Перестановки - изменение порядка слов при несовпадении смыслового центра предложения.

Замены, которым могут подвергаться как части речи, так и члены предложения. Часто замены сопровождаются перестройкой всего предложения при передаче английской пассивной конструкции действительным залогом в русском языке. К замене относится и **антонимический перевод,** при котором отрицательная структура заменяется утвердительной. Лексико-семантические замены - это способ перевода лексических единиц иностранного языка путем использования единиц языка перевода, которые не совпадают по значению с начальными, но могут быть выведены логически. **Прием смыслового развития** заключается в замене словарного соответствия при переводе контекстуальным, логически связанным с ним.

Опущения - во всех случаях семантического дублирования - при переводе парных синонимов опускается повтор.

Добавления - не добавление смысла, а добавление слов для сохранения смысла предложения.

Виды перевода:

Перевод путем использования русских эквивалентов, т.е. постоянных и равнозначных соответствий в двух данных языках, в большинстве случаев не зависящих от контекста.

Перевод с помощью аналогов, т.е. слов синонимичного ряда. В этом случае одному иностранному слову соответствует несколько русских слов. Необходимо выбрать вариант, наиболее подходящий по контексту.

Калькирование или дословный перевод состоит в переводе английского слова или выражения путем точного воспроизведения их средствами русского языка, при этом сохраняется структура предложения, каждое слово переводится так, как оно дано в словаре. Калькирование - воспроизведение не звукового, а комбинаторного состава слова или словосочетания, когда составные части слова (морфемы) или фразы (лексемы) переводятся соответствующими элементами переводящего языка. Дословный перевод используется при совпадении в английском и русском языке структуры предложения и порядка слов. Перевод является дословным, если в нем сохранены те же члены предложения и тот же порядок их следования, как и в оригинале. От дословного перевода необходимо отличать недопустимый в переводческой практике буквальный перевод, т.е. простой механический перевод слов иноязычного текста в таком порядке в каком они следуют в нем, без учета их синтаксических и логических связей. В буквальном переводе встречается наиболее распространенное значение слова или грамматической конструкции без учета всего контекста. Синтаксическое уподобление или дословный перевод - такой перевод, при котором синтаксическая структура оригинала преобразуется в абсолютно аналогичную структуру переводного языка.

Описательный перевод используется для перевода английских слов, не имеющих лексических соответствий в русском языке. Передача значения английского слова при помощи более или менее распространенных объяснений используется для объяснения неологизмов. Описательный перевод имеет место, когда полностью расходятся грамматические структуры английского и русского языков, вызван особенностями сочетаемости слов английского языка.

Транслитерация - передача буквами русского письма букв английского письма, независимо от произношения английского слова. Иными словами, транслитерация - формальное побуквенное воссоздание исходной лексической единицы с помощью алфавита переводящего языка, буквенная имитация формы исходного слова. При этом исходное слово в переводном тексте представляется в форме, приспособленной к произносительным характеристикам переводящего языка. Прием транслитерации можно использовать в тех случаях, когда передаваемая реалия вызывает у читателя твердо укрепившиеся ассоциации, в противном случае транслитерация должна сопровождаться соответствующим примечанием, раскрывающим смысл данной реалии. Транслитерация целесообразна тогда, когда желательно воспроизвести лаконизм подлинника и сохранить специфическую характеристику данной реалии в иностранном языке.

Транскрибирование - передача произношения английского слова русскими буквами. Это основной прием перевода при передаче имен и названий. Переводческая транскрипция - это формальное пофонемное воссоздание исходной лексической единицы с помощью фонем переводящего языка, фонетическая имитация исходного слова.

Членение и объединение предложений используется при переводе специфических конструкций, не имеющих соответствия в русском языке. Различают внутреннее членение (замена простого предложения сложным) или внешнее членение (превращение развернутого предложения в два или более предложения).

Конкретизация - это способ перевода, при котором происходит замена слова или словосочетания иностранного языка с более широким предметно-логическим значением на слово в переводе с более узким значением.

Генерализация (процесс, обратный конкретизации) исходного значения имеет место в тех случаях, когда мера информационной упорядоченности исходной единицы выше меры упорядоченности соответствующей ей по смыслу единицы в переводящем языке и заключается в замене частного общим, видового понятия родовым. При переводе с английского на русский этот прием применяется гораздо реже, чем конкретизация. Достаточно широко этот прием используется при переводе таких слов, как: *to be, to have, to get, to do, to take, to give, to make, to come, to go* и т.д.

Грамматические трансформации заключаются в преобразовании структуры предложения в процессе перевода в соответствии с нормами переводного языка. Если рассматривать отдельные виды грамматических трансформаций, то, пожалуй, наиболее распространенным приемом следует считать замену английских существительных русскими глаголами. Это явление связано с богатством и гибкостью глагольной системы русского языка.

Чисто **грамматическая замена** применяется, когда единица иностранного языка преобразуется в единицу языка перевода с иным грамматическим значением, однако, имеющим тоже самое логическое. Например, замена глагола на существительное, множественного числа на единственное и т.д.

2.1. Лексические трансформации в переводе

2.1.1. Переводческий прием «добавления»

Перевод, который удовлетворял бы специалиста, должен правильно передавать смысл иностранного текста, соответствовать нормам русского языка и стилю научно-технической литературы. Чтобы добиться этого, нужно владеть определенными знаниями в области грамматики и приобрести соответствующий словарный запас. Однако этого недостаточно. Достижение переводческой эквивалентности или “адекватности перевода” требует от переводчика умения произвести многочисленные и качественно разнообразные межъязыковые преобразования – так называемые **переводческие трансформации**.

Все виды преобразований или трансформаций, осуществляемых в процессе перевода, можно свести к четырем основным типам: перестановки, замены, добавления, опущения.

При лексических заменах в переводе происходит замена отдельных слов или словосочетаний исходного языка словами или словосочетаниями языка перевода, которые не являются их словарными соответствиями. Переводчик подбирает вариант перевода, подходящий для конкретного случая, такой вариант перевода называют **контекстуальной** заменой. Переводческая практика выработала некоторые приемы, используемые для создания контекстуальных замен. Наиболее распространенными среди них являются:

прием конкретизации;
прием генерализации;
прием антонимического перевода.

Переводчик иногда бывает вынужден добавлять слова в тексте перевода, чтобы не нарушать нормы русского языка.

Например:

The jet airliner carried 78 passengers and 4 crew.

На борту воздушного лайнера было 78 пассажиров и 4 члена экипажа.

При выполнении перевода необходимо помнить следующие правила:

1. Если в предложении употребляется сочетание «существительное + существительное» или «прилагательное + существительное», то при переводе часто используют добавления, особенно если сочетание носит терминологический характер.

Например:

solid engine – двигатель на твердом топливе;

2.Если английское существительное во множественном числе не имеет адекватной русской формы, то при переводе следует использовать добавления.

Например:

industries – отрасли промышленности;

3. Эллиптическая конструкция if any (if anything) характеризуется пропуском оборота there is (are).

Если в английском предложении встретилась эллиптическая конструкция if any (if anything), используйте при переводе прием добавления и в качестве рабочего варианта примените оборот «если таковые имеются». Затем перевод отредактируйте в соответствии со смыслом всего предложения.

Например:

The nucleus determines the radioactive properties, if any, of the atom.

Ядро определяет радиоактивные свойства атома, если он таковыми обладает.

4. Если глагол в английском предложении управляет одним существительным при помощи разных предлогов, а в русском языке эти предлоги требуют разных падежей, то существительное должно быть повторено при переводе дважды или заменено соответствующим местоимением.

Например:

An antenna radiates most efficiently at or near its fundamental wave.

Антенна излучает наиболее эффективно на основной волне или вблизи основной волны (нее).

Данный прием перевода связан с тем, что английским предложениям свойственна компрессия. То, что ясно носителю английского языка, требует добавления в русском варианте, чтобы не выйти за рамки нормы русского языка. Это относится к словам, которые не носят характер смыслового добавления.

Например:

I saw *a face* watching me out of one of the upper windows.

Я увидел лицо *человека,* наблюдавшего за мной из одного из верхних окон.

The IMF mission is to arrive in Minsk on May 20. The *staff* will *focus* on the general macroeconomic indicators.

20 мая в Минск должна прибыть миссия МВФ. Сотрудники *фонда* сосредоточат *вн имание* на общих макроэкономических показателях.

"Jupiter" is *4 0percent* owned by individual shareholders.

Компания "Юпитер" *на* 40 процентов принадлежит индивидуальным акционерам.

Задание 1. Прочитайте и переведите следующие сочетания. Сделайте в тексте перевода необходимые добавления:

pay claim; wage strike; oil countries; electricity cut; labour spy; logical computer; wages demand; the road plans.

Задание 2. Переведите следующие существительные во множественном числе. Сделайте необходимые добавления:

weapons, uses, defences, applications, technologies, philosophies, practices, activities.

Задание 3. Предложите русскую версию перевода, применяя метод добавления:

1. The flowers *carpeted* the hills and fields.
2. She has never travelled *internationally.*
3. They watched the criminal *out of the court room.*
4. *Professionally,* he can be completely relied on.
5. *According to* the company's president, the reorganization is inevitable.
6. There were no *villagers* nearby to ask the way.
7. He *stole* a look at the girl.

Задание 4. Переведите предложения. Сделайте необходимые добавления при переводе.

1. In industries like steel, machine tools, consumer electronics, and autos, American firms are confronted with foreign producers that can produce at lower cost than they can.
2. Many factors, including new technologies like microelectronics and biotechnology, influence the rate of increase of labour productivity.
3. There are many reasons why management practices vary.
4. The manager directs, motivates, and coordinates people in the various activities required to get the needed work done right and on time.
5. Efficient generation, transmission and distribution of electricity require alternating current, but very many applications make use of direct current.
6. The application of electricity to many uses is one of the greatest achievements of the 19th century.
7. The door is now open to low-cost electronic sensing systems that are accurate, reliable and versatile in vehicle and other applications.

Задание 5. Переведите группы слов и предложения с эллиптической конструкцией if any (if anything).

а) The profits, if any, . . .
The benefit, if any, . . .
The unemployed, if any, . . .
The radioactive products, if any, . . .
The new methods, if any, . . .
б) 1. It would have been too much to expect definite signs of life on Mars, but scientists have confirmed that Mars has few mountains, if any.

2. This indicates, if anything, an absolutely new phase in the development of cybernetics.
3. In the past 20 years the study of flying saucers has little added, if anything, to scientific knowledge.
4. The laboratory has received very few new devices lately, if any.
5. Over a period the subordinates have asked their managers and supervisors what advice, if any, they could give them in this matter.

Задание 6. Переведите предложения с двойным управлением.

1. At the beginning of the 20th century people did not think of flying at or above the speed of sound.
2. This method was designed for and will find its widest application in data analysis.
3. The world of tiny things is invisible to and unseen by most of us but is just as real as we are.
4. Chlorine both combines with and replaces hydrogen.
5. A manager must be able to «read» the people who work for him, and with him, accurately.

2.1.2. Переводческий прием «опущения»

В ряде случаев переводчик бывает вправе делать некоторые опущения, если это необходимо для избегания нарушения лингвистических или стилистических норм русского языка. В переводе чаще всего опускаются семантически избыточные слова. Этот прием перевода используется в случае избыточности информации, которая представляет собой нарушение норм русского языка.

Например:

He leaned forward to take the paper. - Он наклонился, чтобы взять бумагу.

Иногда опущения при переводе вызваны различиями в структуре английского и русского предложений. В русском языке нет необходимости в полном наборе всех членов предложения:

The first *thing* I did *was* to give her a call. – Первое, что я сделал, позвонил ей.

Часто опускаются притяжательные местоимения, которые в русском переводе являются избыточными:

He took *his* bag in *his* right hand. - Он взял сумку в правую руку. Однако используя прием опущения, необходимо помнить, что это не лазейка для пропуска трудных мест при переводе. Смысл предложения не должен быть искажен.

Прием опущения следует применять также при переводе так называемых “парных синонимов”. **Парные синонимы** – параллельно употребляемые слова одинакового или близкого значения, объединенные союзами and или or. Русскому языку это явление совершенно не свойственно. Если в английском предложении употреблены парные синонимы, то при переводе рекомендуется один из них опустить, т.е. заменить два слова – одним.

Например:

regular and normal обычный

happily and fortunately к счастью

by force and violence насильственным путем

precision and accuracy точность

The town we stayed in was very *nice and attractive.* - Город, в котором мы остановились, был *очень уютным.*

The treaty was pronounced *null and void.* - Договор был признан *недействительным.*

Задание 1. Переведите следующие предложения и словосочетания, применяя метод опущения*:*

1. He jumped to his feet and ran after them.
2. Why scratching your left ear with your right hand?
3. The invaders came to kill and murder civil population.
4. Working men and women deserve a better life.
5. We were sick and tired of waiting for hours and hours.

Задание 2. Переведите предложения. Обратите внимание на парные синонимы.

1. The resistance or opposition to the flow of current is measured in ohms.
2. The treaty was pronounced null and void.
3. Alloy grey iron is easy to machine because most of the carbon present is in free or uncombined state.
4. The proposal was rejected and repudiated.
5. Burning or combustion is the process of uniting a fuel or combustible with the oxygen in the air.
6. Cylindrical coordinate robots meet requirements for speed, precision and accuracy.

2.1.3. Лексические замены. Переводческий прием «конкретизация»

Прием лексических замен довольно широко используется при переводе в. тех случаях, когда отсутствуют прямые словарные соответствия. В этом случае необходимо найти вариант перевода, который подходит для данного контекста, например:

Privacy was impossible. - Было невозможно побыть одному. Invasion in *one's privacy*- вмешательство в чью-л. личную жизнь.

Контекстуальная замена как вид лексической трансформации используется в тех случаях, когда необходимо сделать уточнение *(конкретизацию),, обобщение (генерализацию),* а также заменить отрицательную конструкцию на утвердительную или наоборот *(антонимический перевод)* или полностью *переосмыслить высказывание* (например, при переводе фразеологизмов).

Конкретизация представляет собой замену слова или словосочетания исходного языка с более широким значением словом или словосочетанием языка перевода с более узким значением. В английском языке много слов с общим широким значением и десемантизированных слов, которые при переводе всегда в той или иной мере конкретизируются.

Следующие слова наиболее часто подвергаются конкретизации:

case, failure, nation, thing, effort, formulation, one, trouble, element, industry, piece, violence, facilities, matter, point, work, to be to leave, to go, to say, to come, to tell.

Например:

The curtain went up. - Занавес *поднялся.*

The facilities were downstairs. - *Удобства* находились внизу.

Put him on the phone please. - Позови его, пожалуйста, к телефону.

Любое, казалось бы, хорошо знакомое, слово в зависимости от контекста (и от того, в каком словосочетании оно встречается) может иметь совсем иное значение.

Например:

the interests of the community интересы общества black community- негритянское население

financial (business) community - финансовые (деловые) круги

technological community - техническое сотрудничество

community of interests - общность интересов

European Economic Community - Европейское экономическое сообщество

Задание 1. Переведите следующие предложения и словосочетания, применяя метод конкретизации:

1. *Things* look promising.
2. *The meal* was served at 6 p.m.
3. It *will take* me about an hour to drive there.
4. All the hotels in the city provide *parking facilities.*

Задание 2. Сравните английский и русский варианты. Обратите внимание на способы конкретизации а) глагола to be; б) существительного industry.

а) He is at school. Он учится в школе.
He is in the Army. Он служит в армии.
The book is on the table. Книга лежит на столе.
The TVset is by the wall. Телевизор стоит у стены.
б) 1. The automotive industry has been working with the electronics industry, exploring a wide range of solutions involving microprocessors.

Автомобильные компании совместно с представителями электронной промышленности исследуют широкий круг возможных подходов к решению проблем, связанных с применением микропроцессоров.
2. . . . here or there in the semiconductor industry.
. . . на том или ином предприятии электронной промышленности.

Задание 3. Конкретизируйте слово thing. Выберите один из возможных вариантов перевода.

Thing – вещь, предмет, дело, факт, случай, обстоятельство, существо, проблема, вопрос, фактор, произведение, черта и др.
1. How are things?
2.Things look promising.
3.I want to look into the thing myself.
4. All organizations share one thing in common: they have to be managed.
5. According to one standard definition, a resource is a thing or service used to produce goods (or services) which can satisfy wants.
6. In economics one thing is obvious: you cannot escape the problem of choice.
7. Many experts believe that the only truly important thing in determining productivity within a plant is management.
8. Fixing priorities is the most important thing for a manager to save time.

Задание 4. Дайте русский вариант следующим предложениям.

1. The college has excellent research facilities.
2. The phone is equipped with a call-back facility.
3. There was also fierce local opposition in June to plans to build the world's largest nuclear waste facility near Krasnoyarsk.
4. The hotel has its own pool and leisure facilities.
5. Excuse me, I have to use the facilities.
6. The company is ready to meet the challenges of the next few years.
7. I relish the challenge of rebuilding the club.
8. I like the challenge of learning new things.
9. In grade school, Clint was a real challenge to all of his teachers.
10. The president faces a strong challenge from nationalists.
11. Billboard companies say they will challenge the new law in court.
12. Many doctors have challenged the accuracy of his findings.
13. I'm really at my best when I'm challenged.
14. Its performance on mountain roads was impressive.
15. The new program will better evaluate the performance of students and teachers.
16. Targets may be set for any parameter that can be measured as the project proceeds, such as cost, time and performance.
17. Three criteria have been chosen, attempting to measure the most important attributes of company performance over the year.

18. As an employee, his record is outstanding.
19. The department has a long record of high achievement.
20. It (HMA) has a great track record of managing hospitals.
21. The industry's record on conservation is not very impressive.
22. Lawrence promised full commitment in his drive to make Santa Barbara College the most successful school in the region.
23. Many parents do not get involved in schools because they have too many other commitments.
24. Thanks to your energy and commitment, the fundraiser was a great success.
25. The US President expressed America's commitment to Africa's economic development.
26. The governor has a strong commitment to creating jobs in the state.
27. A very high percentage of small businesses fail within their first year.
28. Across the state, corn crops failed due to the drought.
29. If your marriage fails, it can be difficult to make a new start in life.
30. The banks have committed themselves to boosting profits by slashing costs.

2.1.4. Переводческий прием «генерализация»

Генерализация – замена слова, имеющего более узкое значение, словом с более широким значением.

Например:

She visits me practically every week-end.

Она бывает у меня почти каждую неделю.

She was *killed* in a car accident.

Она *погибла* в автокатастрофе.

To the last ounce of effort - из последних сил.

He visits me practically every weekend. – Он ездит ко мне почти каждую неделю.

He showed us his old beat-up Navajo blanket. – Он показал нам свое потрепанное индейское одеяльце.

I saw a man 6 feet 2 inches tall. – Я увидел высокого парня.

Задание 1. Переведите следующие предложения и словосочетания, применяя метод генерализации:

1. Two persons were reported *shot.*
2. The dog sniffed *every inch* of the ground.
3. *A 120-voice choir* was performing in the open air
4. *The five-minute meeting* with reporters was over.

Задание 2. Переведите на русский язык следующие предложения.

1. Then this girl gets killed, because she's always speeding.

2. "Who won the game?" I said. "It's only the half."
3. Jane used to drive to market with her mother in their La Salle convertible.
4. She closed the bathroom door behind her, sat on the edge of the bathtub, and smoked a Virginia Slim.
5. The pizza was from Domino's, not some leathery slab of cheese someone threw in a microwave, but a real pizza Doreen had probably paid for.
6. Did you guys have a little meeting with Judge Roosevelt this morning?
7. It'll be more than a headache, I promise. [...] I'll notify the Equal Employment Commission, the National Labor Relations Board, the IRS, OS HA, and anybody else who might be interested. I'll make you lose sleep, Chester. You'll wish a thousand times you hadn't fired my client.
8. Mark looked at her without blinking for a long minute, and convinced himself she could be trusted.
9. He weighed somewhere between three and four hundred pounds, and wore the same outfit every day – black suit, white cotton shirt, and a bow tie which he tied himself and did so poorly.

2.1.5. Переводческий прием «антонимический перевод»

Антонимический перевод – широко распространенная в переводческой практике комплексная лексико-грамматическая замена. Суть ее заключается в трансформации утвердительной конструкции в отрицательную (или наоборот), сопровождаемой заменой одного из слов переводимого предложения на его антоним в языке перевода.

Например:

а) He didn't say anything. Он промолчал.

отрицательная конструкция → утвердительная

глагол say (сказать) → промолчать

б) Keep off the grass! Не ходите по траве!

Утвердительная конструкция → отрицательная

It's *not uncommon* for families in rural areas to have three and more children.

В сельской местности в семьях *обычно* бывает по трое и более детей.

Remember to wake me up at 7 a.m. - *Не забудь* разбудить меня в 7 утра.

They *never* found out *until* afterward what he had to go through.

Они *лишь впоследствии узнали,* что ему'пришлось пережить.

Иногда антонимический перевод является единственно возможным средством для достижения адекватного перевода:

The *last thing I would like to do* is to spoil our relationships.

Мне бы *очень не хотелось* испортить наши отношения.

The *inferiority* of the enemy - *Превосходство* наших войск.

Обратите внимание на перевод следующих предложений и словосочетаний:

Hang on, please! Не кладите трубку, пожалуйста!

Stay out of the sun! На солнце лежать нельзя!

Staff only. Посторонним вход воспрещен.

Keep clear of the door! К двери не прислоняться!

To be second to none - не иметь себе равных

to overlook - не придавать (придать) значения.

to be free of - не содержать

to be as good as - уе уступать

to be self-explanatory - не требовать объяснения

to keep up/pace with - не отставать

to be immune to - не поддаваться воздействию

to disregard/discount - не принимать во внимание

It should be recalled that such discussions create a dangerous precedent.

Нелишне напомнить, что дискуссии подобного рода создают опасный прецедент.

It is just as important to comply with treaties already signed.

Не менее важно соблюдать уже подписанные договоры.

Следует помнить, что антонимический перевод применяется при передаче на русский язык английской конструкции с not . . . until; при этом until заменяется на лишь тогда; только тогда, когда.

Например:

It was not until the 17-th century that man began to understand the pressure.

Только в 17 веке человек начал осознавать, что такое давление.

Задание 1. Переведите на русский язык следующие предложения.

1. He is no linguist.
2. No two international problems are alike.
3. It was not until he has read for several days that he came upon a story that quickened his pulse.
4. I don't at all disbelieve you.
5. They passed no village bigger than a hamlet and no inn better than an alehouse, but Harry was urgent to stop at one of them and seek better horses.
6. If ever you are anywhere in the province of Bourgogne, don't fail to visit the inn called "At the Sign of the Reine Pedoque".
7. "A Forsyte," replied young Jolyon, "is not an uncommon animal.
8. " It is not unlike me that in heading toward the West I should travel east.
9. Style is a matter of which a foreigner, even though he knows the language pretty well, can be but an uncertain judge: the finer points, the music, the aptness, the rhythm, can hardly fail to escape him.
10. Reggie was no stranger to the apartment.
11. The thumb never left his mouth.
12. Reggie wondered if the poor child had ever left Memphis.
13. I don't completely distrust them.
14. At some point, about halfway to the jet, Mark stopped.
15. He was a tough little kid, raised on the streets and wise beyond his years.

Задание 2. Переведите следующие предложения и словосочетания, применяя метод антонимического перевода:

1. Their attitude was *not unfriendly.*
2. She had *not* left the reception *until* after her driver came to pick
3. her up.
4. They had *little* to say to each other.
5. The permission is *not* given *unless* authorized by the dean.
6. Her name does *not* sound *unfamiliar* to me.

Задание 3. Переведите следующие предложения. Используйте прием антонимического перевода.

1. Your name is not unknown to me.
2. Did you remember to post the letters I gave you?
3. I believe such stories are not uncommon.
4. The tones of her voice were clear and not unmelodious.
5. He remembered to be polite.
6. Keep out! We are not ready yet.
7. He was not old enough.
8. Are you awake? – Yes, I am. I am not well today.
9. It is not an unfavourable moment to make use of transducer-based technology.
10.The case is not improbable.
11. Mars and Venus have atmospheres not dissimilar to ours.
12.River and lake deposits also not uncommonly contain remains of organisms which inhabited waters.

Задание 4. Переведите следующие предложения, обращая внимание на перевод конструкции not . . . until;

1. It was not until around 1610 when Galileo first observed Saturn through his telescope.
2. It was not until 1600 that it was discovered that glass and certain other materials could be electrified.
3. It was not until the last quarter of the seventeenth century that some of the fundamental operating principles of the rocket were explained.
4. It was not until the 20-th century that physicists arrived at a satisfactory theory of the structure of the nucleus.
5. It was not until 1609 that the German astronomer J. Kepler described planetary paths correctly for the first time.
6. It was not until Reontgen discovered X-rays that scientists began to take interest in this subject.

2.1.6. Переводческий прием «целостное переосмысление»

Целостное переосмысление наиболее трудный вид контекстуальной замены при переводе. Заключается в понимании английского устойчивого словосочетания (фразеологизма) и передаче его по-русски совершенно другими лексическими средствами:

To be an albatross	Быть обузой (ярмом) (around one's neck)
Work and pleasure	Полезное с приятным
No way!	Ни за что! (Ни в коем случае!)
Stretch one's leg	Размяться
Jack of all trades	Мастер на все руки
Still waters-run deep	В тихом омуте черти водятся
In the nick of time	В последний момент

Задание 1. Переведите следующие предложения и словосочетания, применяя метод целостного переосмысления*:*

1. Sleep on it, tomorrow is a new day.
2. Robbing Peter to pay Tom.
3. It's easy to be wise after the event.
4. No gain without pain.
5. Do as you would be done by.
6. Black sheep.
7. Re-inventing the wheel.
8. When in Rome, do as the Romans do.

Задание 2. Переведите следующие предложения, используя метод лексической трансформаций, в каждом из случаев укажите, какая из разновидностей лексической трансформации использована вами.

1. Price rise is not unlike to remain in the forthcoming period.
2. The U.S. and EL) remain split over the OECD chief.
3. I can read you like a book.
4. Faithful to their plan, the members of the crew dressed themselves in their oldest uniforms.
5. The operation was carried out neatly and .smartly.
6. The final result was a minor matter for him.
7. In the country of one-eyed be one-eyed.
8. Meeting such results is vital for the company's development.
9. Andrew Rose, an economist at the University of California, says that being a member of the WTO makes no difference to how much countries trade with each other.
10. They also have committed themselves to reforming the costly agricultural policy.

11. The EU newcomers must attract a new wave of foreign direct investment to remain competitive.
12. Decision-making in Brussels, already slow and complex, will be more difficult with 25 members at the table.
13. The one-minute shock was over, and all returned to their duties.
14. That's a 25% jump over the year-earlier period.
15. The models of development are now struggling.
16. A year or two ago, the bank would have granted a loan without a second thought.
17. Most of the company's output is sold domestically.
18. All of the company's offices around the world are staffed with locals.
19. Two dozen countries that kiss the Caribbean Sea seem to be a dream
20. When it comes to the environment, big American companies like to appear green.
21. The UN Center for Economic and Social Information in Geneva publishes "Development Forum Business Edition", a biweekly newspaper.
22. Actually the decision had been taken hours before the Intel news went public.
23. It'll be a good thing if they are able to stabilize the situation.

Задание 2. Переведите предложения. Используйте все известные вам переводческие трансформации.

1. Compared with the previous methods these offer a great reduction in size, higher efficiency and lower cost.
2. When many things come together, breakthroughs happen.
3. Some things never change.
4. He had not done badly at his new job.
5. This went nowhere.
6. In many cases, anticipation results in prevention.
7. Touching a bare wire may result in electrical shock, unless mittens or gloves of some insulating material are used.
8. It wasn't until almost a decade later that the company began to see the impact of its inventions.
9. There was a natural marriage between digital and IC technology.
10. Change doesn't happen in straight lines – there are sharp jumps and very flat plateaus.
11. A close working relationship between design and manufacturing engineering is not a naturally occurring phenomenon in all companies.
12. The present data show good agreement.
13. We struggled for months with the name for the new device.
14. The cost of computers becomes prohibitive.
15. It was not until about 1911 that a first really successful theory of atomic structure was suggested by E. Rutherford.
16. Long chains of chemically linked molecules called polymers are the building blocks of modern materials ranging from plastics and paints to synthetic fibers.

17. PC software companies are trying to make customers pay extra for technical support.
18. Today’s network managers are faced with trying to satisfy the growing demand to connect LANto-LAN based users at different sites and to provide users with dial-out access to commercial E-mail services.
19. An important future consideration is that PCI and other local-bus systems have high-frequency loading, which limits the number of slots.

2.2. Грамматические трансформации в переводе

2.2.1. Местоимение “It”

Models:

1. Предваряющее “It”.

a) It is + adj.

It is necessary to apply for a patent in order to protect a new discovery.

Для того, чтобы защитить право на новое изобретение, необходимо обратиться за патентом.

b) It is + Part II + that

It is expected that the first month of the trial will be taken up with selecting the jury.

Ожидается, что первый месяц судебного процесса уйдет на выбор состава присяжных.

c) It is + noun + that

It is a common misconception as to the law of contracts that an agreement is not binding if it is not in written form.

Распространенным заблуждением в договорном праве является то, что соглашение не обязательно, если оно не заключено в письменной форме.

2. Формальное “It”.

Some people disapprove of law that makes it compulsory to fix seat belts to cars.

Некоторые люди не одобряют закон, делающий обязательным оборудование машин привязными ремнями.

Задание. Переведите, обращая внимание на обороты с местоимением It.

1. It is not usual to haggle about prices in a British shop, as it is in, say, a Turkish market.
2. It is necessary to have a clear picture of a staggering amount of crime and how various classes and strata are affected by it.
3. It is felt that society cannot work if people are allowed to take the property of others at will: therefore theft is forbidden and thieves are punished.

4. People continue to rely on written agreements for years but if a serious disagreement arises they may decide it necessary to take a legal action.
5. The jury is to decide questions of fact, and it is the judge's responsibility to guide them on questions of law.
6. Most countries find it convenient to set up separate systems of criminal and civil courts.
7. It is important to consider to what extent descriptive and prescriptive laws can be distinguished from customs and social rules.
8. In many legal systems it is an important principle that a person cannot be considered guilty of a crime until the state proves he committed it.
9. Under resolutions which were adopted by the UN General Assembly it is the duty of every state to pursue and punish war criminals.
10. The vagrancy laws, some judges observe, make it a crime to be poor, downtrodden and unemployed.
11. It should be noted that the phrase "common law" is sometimes used in England today to describe the whole body of judge-made rules.
12. In order to separate the role of the legislature and judiciary, it was necessary to make laws that were clear and comprehensive.
13. It is a crime to drink alcohol in Saudi Arabia, but not in Egypt. It is a crime to smoke marijuana in England but not (in prescribed places) in the Netherlands.
14. For some people, the image of a lawyer is someone who leads a very wealthy and comfortable life; however, it should not be forgotten that there are also lawyers whose lives are not so secure.
15. If it is thought that one of the parties to a case has further information which should be disclosed , it is possible to apply for permission to reveal it.

2.2.2. Слова Заместители "That", "Those"

Model:

The most urgent question everywhere in this country today is that of complying with the law.

В наши дни наиболее неотложной проблемой во всех уголках нашей страны является проблема соблюдения законности.

Задание. Переведите, обращая внимание на правило «слова заместители».

1. According to specialists the two central banks most independent of the government are those of Switzerland and Germany.
2. Many companies invest their profits in such spheres as sophisticated technologies and those giving fast returns.
3. Partnerships can be formed easily and the legal position of partners is not very different from that of sole traders.

4. Ordinary Americans are much more interested in local politics than in those at the federal level.

5. The political power of the US Secretary of State is second only to that of the President.

6. The system of checks and balances is such an arrangement of government powers where powers of one government branch check and balance those of other branches.

7. Most legal systems in Europe, including that of Scotland and indirectly those in many other parts of the world, were strongly influenced by Roman Law.

8. The House of Lords is considered the upper house of the British Parliament, but its political powers are much more limited than those of the lower house , the House of Commons.

9. International law comprises the regulation of relations between governments and also between private citizens of one country and those of another.

10. The definitions of many torts closely resemble those of crimes.

2.2.3. Сложное Подлежащее с Инфинитивом

Model:

The trial, which has been rumored everywhere for so long, is believed to be nearly completed.

Полагают, что судебный процесс, о котором повсеместно так долго ходят слухи, почти завершен.

Задание. Переведите, обращая внимание на конструкции сложного подлежащего с инфинитивом.

1. The economic situation in this country is reported to be improving.
2. The conference is expected to be held on the premises of the Academy.
3. When are we supposed to take our exam in international law?
4. The invention is expected to be of great importance for the protection of the environment.
5. Political stability is generally thought to be a good thing, but economic changes are usually inevitable.
6. The registration of a company may be cancelled if its objects turn out to be illegal.
7. Contract damages are merely intended to compensate a plaintiff for his loss.
8. A lot of research has shown that people are more likely to read and believe publicity than advertising.
9. He seems to have excluded himself from the vice-presidential candidacy at the time when the public opinion polls report that he is most popular. 10. The British Queen is expected to be impartial or “above politics” and her political advice to the Prime Minister is kept secret.
11. A barrister is required to have reached an accepted educational standard and to have become a member of the Inns of Court.

12. In recent times lawyers have made efforts to make their profession less mysterious; after all their job is supposed to clarify matters for the public, not to make them more complicated.

13. Lawyers try to explain exactly why a judicial decision has been made, even when the decision appears to be obvious common sense.

14. The overall acquittal rate is said to be increasing now that defendants have the right to be tried by a jury.

15. Due to the system of checks and balances the President is not as powerful as many people outside the US seem to think he is.

2.2.4. "For" – фразы с инфинитивом

Model:

1. It is cheaper for a company to issue bonds than shares.

Компании дешевле выпускать облигации, чем акции.

2. Some industrial projects are too sophisticated for experts to evaluate their effect on the environment.

Некоторые промышленные проекты слишком сложны, чтобы эксперты могли оценить их влияние на окружающую среду.

Задание. Переведите, обращая внимание на перевод "for" фраз с инфинитивом.

1. The problem under discussion was too complicated for the participants in the Congress to cope with.
2. All these factors aggravated the debt problem and it was impossible for the country to meet its external debt service obligations in time.
3. One of the ways to run a business is for two or more people to form a partnership in which they share management, profits and liabilities to debts.
4. The WTO is a forum for member governments to negotiate trade agreements and to try to sort out trade problems.

5.Judges do not merely apply the law, in some cases they make law, and their interpretations may become precedents for other courts to follow.

6.As a first step it is customary for the solicitor to try to settle a dispute without litigation.

7.It is necessary for at least ten of the twelve jurors to agree in order to find a defendant guilty.

8.Immediately after judgement has been given, it is usual for the counsel for the successful party to ask for costs, and this is a matter for the judge's discretion.

9.Cabinet officials are appointees of the President, so when the President's service ends it is customary for the Cabinet to resign.

10.The US Special Courts have been established to handle cases which are sometimes difficult for a judge to understand.

2.2.5. Герундий в Различных Синтаксических Функциях

Models:

1. Rewriting laws is a slow and painstaking process.

Пересмотр законов – это длительный и трудоемкий процесс.

2. Sometimes we can break rules without suffering any penalty.

Иногда мы можем нарушать правовые нормы, не подвергаясь наказанию.

3. Some people have gone so far as describing political power (a consequence of lobbying) as one of the main components of marketing.

Некоторые люди зашли так далеко, что считают политическую власть (результат лоббирования) одной из основных составляющих маркетинга.

Задание. Переведите, обращая внимание на особенности перевода герундия.

1. In England the main decision for a future lawyer is between becoming a barristor or solicitor.
2. Many people believe the distinction between barristers and solicitors should be eliminated, but there are arguments for maintaining as well as removing the distinction.
3. Nearly every general area of law is relevant to running a business.
4. Some transactions are so complex that few of us would risk making them without seeking legal advice: for example, buying or selling a house or setting up a business.
5. In many countries there are law firms that specialize in dealing with people who would not be able to pay for legal services out of their own pockets.
6. Legal systems have rules for interpreting contracts in which one or more contractors made a mistake or was pressed into making an agreement.
7. People are always looking for legal loopholes, a way of avoiding a legal duty by making use of an ambiguity in law.
8. In countries where there is much political corruption certain people are able to escape justice by using their money or influence.
9. Common law or case law system differs from Continental law in having developed gradually throughout history.
10. On coming to office the British Prime Minister has to fill about seventy ministerial positions from the ranks of his supporters in Both Houses of Parliament.
11. If a partnership was set up for an indefinite period, it can be ended by any partner giving notice to all of the others.
12. Financial legislation may become law within a month of its being passed by the Commons, regardless of the attitude of the Lords.
13. Courts are often criticized for being biased, and incidents of judges handing down guilty verdicts to defendents under pressure from prosecutors are widespread.
14. Briefing a case is preparing a short digest of the facts, issues and reasoning essential to the court in making its decisions.

15. Reading and discussing “case reports” are considered especially apt tools for teaching students the kind of precise reasoning which is instrumental to a lawyer’s work.

2.2.6. Причастия I, II и Инфинитив в Функции Определения

Задание. Переведите, соблюдая правила перевода причастия и инфинитива.

1. They were fully aware of the obstacles to be faced and the changes to be made.
2. Against the background of the falling living standards, the profits earned by the monopolists seemed particularly great.
3. The internal management of a company is regulated by a document called the articles of association.
4. *Tariff barriers are often imposed to protect infant industries being developed as a means of import substitution.
5. If you want to set up business under English law, the first question to consider is to form a limited company or not.
6. The quality of goods received must correspond to the specifications stipulated in a contract signed by companies.
7. The Chinese government has responded to a growing demand for better quality goods and set up special courts to deal with customers’ complaints.
8. The contract contains a clause providing that all disputes raised by the customers should be referred to arbitration.
9. The world monetary system, agreed upon by the Western powers at Bretton Woods at the end of the Second World war, had collapsed by 1971.
10. The London police are under the control of the Home Secretary, acting through a commissioner appointed by and responsible to him.
11. Washington was the first city in history to be created solely for the purpose of governance.
12. In civil proceedings the plaintiff prepares a draft of summons, notifying the defendant in general terms of the nature of the claim against him.
13. The functions of a judge are to conduct proceedings, point out the problems to be clarified, put questions to the parties and witnesses and examine relevant documents.
14. The tort of defamation covers attacks against someone’s reputation through a written or spoken word.
15. A defamatory statement heard only by a person who does not understand the language in which it is spoken is not actionable.

2.2.7. Причастия I и II в Функции Обстоятельства

Models:

1. Commenting on the resolution, he informed the deputies of the country’s critical situation.

Комментируя резолюцию, он сообщил депутатам о критической ситуации в стране.

2.Asked about the claim, he said the dispute would be settled out of the court.

Когда его спросили об иске, он ответил, что спор будет урегулирован вне суда.

Задание. Выполните перевод, соблюдая правила.

1. Speaking at the meeting of the shareholders the President of the Bank tried to explain that the problems caused by inflation would soon be solved.
2. Informed that it was impossible to sack such a number of employees the executive director suggested reducing the company's running costs by some other means.
3. Asked to justify his decision to cut the R and D budget, the head of the company failed to sound convincing.
4. Working as a block, the opposition parties have been able to formulate demands for reforming the economic situation.
5. Asked how he got to be so good in the pre-election campaign the candidate answered "I lost the previous election".
6. Faced with the necessity to comment on the event, the Prime Minister refused to express his opinion.
7. Alleging human rights violations, some countries have imposed economic sanctions against others.
8. Unlike customs, the rules of social institutions tend to be more formal carrying precise penalties for those who break them.
9. Two youths were fined 25 dollars being found guilty of causing a breach of peace.
10. Having arrested someone suspected of committing a crime, the police must decide if they have enough evidence to make a formal accusation.

2.2.8. Независимый Причастный Оборот

Model:

1. The agreement is drawn up in English and in Russian; both texts being equally valid.

Договор составлен на английском и русском языках, причем (и) оба текста имеют одинаковую силу.

2. The documents not having arrived on time, the trial had to be postponed.

Так как документы не прибыли вовремя, судебное разбирательство пришлось отложить.

Задание. Выполните перевод, обращая внимание на правило перевода независимого причастного оборота.

1. The question arose on responsibility, some participants pointing out that laws were neglected everywhere.

2. The parties having failed to conclude an agreement, there is no way of telling what the outcome will be.

3. England appeared only a formal victor in the second world war, its economy entering the period of stagnation and decline.

4. There are about 100 Federal courts throughout the country, final authority resting in the Supreme Court.

5. The USA has no national police force, the FBI influence being limited to a very few federal crimes, such as kidnapping.

6. The American Constitution specifies the powers and duties of each federal branch of government, with all other powers and duties belonging to the states.

7. In any election year, only one third of the Senate is changed, the remaining two thirds being members whose terms have not expired.

8. “Upper” and “lower” are commonly applied to the two houses for a bicameral legislature, the upper being the less numerous and higher in rank of the two.

9. If a dispute arises between two individuals, each believing himself to be in the right, litigation may ensue.

10. Legal unpredictability usually scares off foreign capital, with changes to the R.F.Tax Code happening every year.

2.2.9. Сложное Дополнение с Причастием II

Models:

1. He wanted the writ typed on time.

Он хотел, чтобы судебная повестка была напечатана во-время.

2. She had her case heard by a jury.

Ее дело слушалось судом присяжных.

Задание. Выполните перевод, обращая внимание на перевод сложного дополнения.

1.She wanted her money invested in “wholly ethical companies”.

2.The court ordered him taken into custody on suspicion of participation in a terrorist act.

3.An over the counter market is a market for young and small companies which do not want their shares traded on the major stock-exchanges.

4.If a business does badly and cannot pay its debts, any creditor can have it declared bankrupt.

5.If a person is unable to vote on election day he obtains a ballot within a specified period of time before the election, marks it, has it notarized and returns it to the proper officials.

6. In some states, such as California, citizens can petition to have their propositions put on the ballot in state elections.

7.There are some offences where the defendant is given the choice of having his case heard in the Magistrates Court or the Crown Court.

8.It takes much longer to have a case heard in the Crown Court, but sometimes defendants prefer it because their cases are decided by a jury, that is ordinary people.

9.The Plaintiff can apply to the court for a charging order on the defendant's land or shares and if the money is still not paid, he can have them sold to recover his damages.

10.Where countries have faced trade barriers and want to have them lowered, negotiations within the framework of the WTO are used to liberalize trade.

2.2.10. Модальный глагол "Should" в ослабленном значении

Model:

In Britain there are some cases closed to the public, that is a judge may order that no members of the public (should) be present at the proceedings.

В Британии существуют судебные дела закрытые для публики т.е. судья может приказать, чтобы никто из публики не присутствовал на судебном разбирательстве.

Задание. Выполните перевод, соблюдая правило перевода модального глагола.

1. In order to sustain free trade it is essential that governments should tackle the unemployment problem.
2. One of the business approaches demands that suppliers, customers, employees and members of the local community should be represented on a company's board of directors.
3. The President suggested that Congress should try harder to pass some drug control legislation.
4. In the USA lawyers and courts of law have become part of daily life, whereas in Japan lawyers are few and people tend to rely on informal ways of solving disagreements; it's interesting that two highly industrialized societies should be so different in this respect.
5. Any person may begin and conduct proceedings himself, but because of the difficulties involved it's highly desirable that he be given legal advice.
6. In Japan it is possible for the prosecution to appeal that a non-guilty decision be changed to guilty.
7. If an MP should die or be forced to give up his seat the people of the country will have to vote again in a by-election to replace him.
8. The countries to the Community Treaty accepted the supremacy of Community law over their national systems of law if a conflict should arise.
9. Company directors, partners and sole traders alike have to consider the legal implications of the torts they may face should their products injure a customer.
10. The Supply of Goods and Services Act implies that services be provided with reasonable care, at a reasonable cost and within a reasonable time.

2.2.11. Модальные Глаголы, "May", "Must" Выражающие Предположение, Уверенность

Models:

1. You may (might) have read his account of the case.

Вы возможно (может быть) читали его отчет об этом деле.

2.The parties concerned must have stopped debating the claim.

Заинтересованные стороны, очевидно, (должно быть, наверное) прекратили обсуждение иска.

Задание. Переведите, соблюдая правило перевода модальных глаголов.

1. Economists say that inflation might double and even treble in the near future.
2. The Prime Minister mentioned that a more radical stand on the issue must have enabled his party to avoid defeat.
3. Individual companies might have been more efficient if they had been liberated from central management.
4. Without a constructive means of tackling disputes among WTO member countries, some of them might have led to a serious political conflict.
5. The court can never know exactly what was in the head of a criminal at the time of committing the crime, so it has the difficult task of deciding what his intentions must have been.
6. In most countries a person cannot be found guilty if in a doctor's opinion he might not have been responsible for his action because of mental illness.
7. Civil law determines which of the 2 parties to a dispute is in the right and the party in the wrong is often obliged to compensate the other for any loss that may have been caused.
8. The European Court of Justice is made up of a mixture of professional judges, academic lawyers and public servants unlike the British courts where the judges must all have been practising barristers.
9. Court justices may have been Senators, Attorney Generals or teachers in law schools, before their appointments not all of them were judges or lawyers in private practice.
10. Some countries must have reached advantageous trading positions by achieving low-cost production with methods that are not politically acceptable in many democracies.

2.2.12. Модальные Глаголы "Will", "Would" для Выражения Повторяемости Действия или Привычного Состояния

Models:

In any community man-made rules will develop to control the relationships between its members.

В любом сообществе созданные человеком правовые нормы (обычно) развиваются для того, чтобы контролировать взаимоотношения между его членами.

Задание. Выполните перевод, соблюдая правило о переводе модальных глаголов.

1. In cases where a jury is present in civil proceedings, the judge will sum up the case for jurors, if there is no jury, the judge will deliver his judgement.
2. The judge does, in fact, two things: he gives his actual decision between the parties, and he will also give his reasons for reaching that decision.
3. In High Court there are various ways by which money can be obtained from a debtor who will not pay.
4. In an accident claim the negotiations will usually be between the injured person's solicitor and the other party's insurance company.
5. A defendant found guilty by the magistrates may appeal to the local Crown Court and the Crown Court judge will hear the appeal without a jury.
6. Appeals heard by the House of Lords require a minimum of three judges but in practice five will usually sit.
7. A newly-called barrister will take a room in existing chambers and wait for work to be given to him by a solicitor.
8. When the solicitor does not appear an advocate himself, he will be responsible for matters preparatory to the trial.
9. Discovery of documents means that each side will give the other the opportunity to inspect documents relevant to the case.
10. In England the courts of common law and of equity existed alongside each other for centuries but if an equitable principle would bring a result different from a common law decision on the same case it prevailed.

2.2.13. Эмфатические Конструкции "It is/was … Which/That/Who/When", "Do", "Does", "Did"

Models:

1. It is education that economists regard as the best investment in the future.

Именно (лишь) образование рассматривается экономистами как наилучший вклад в будущее.

2. Freedom cannot be absolute, as we do live in an independent society.

Свобода не может быть абсолютной, так как мы действительно (все-таки) живем во взаимозависимом обществе.

Задание. Выполните перевод, соблюдая правило перевода эмфатических конструкций.

1. It is seats which are important in Parliament, not votes, and it is easy to see why smaller parties would like a system of proportional representation.

2. The Prime Minister is usually leader of the majority party as well as head of Government and it is he who appoints other members of his team.
3. It was not until 1989 when Belgium outlawed corporate political donations.
4. The vast majority of claims in tort are settled without actual resort to the courts and it is only where a settlement proves impossible that proceedings have to be started.
5. If the defendant wishes he can make a counterclaim, alleging that it is he who is the injured party and that it is the plaintiff who has broken a contract or committed a tort.
6. The work of English Magistrates Courts is largely criminal, but they do have a limited civil jurisdiction.
7. In criminal cases the prosecution must prove that the accused did commit the offence: it is not for him to prove that he did not.
8. The WTO cannot claim to make all countries equal, but it does reduce some inequalities, giving smaller countries more voice.
9. Most countries do feel that it's better to be in the WTO system than outside it.
10. It is not the comfort of big city lights but the economic position of the Russian regions that account for the imbalance between Moscow and the regions in terms of foreign investments.

2.2.14. Придаточные Предложения, Вводимые Союзами “Provided”, “Unless”

Provided – при условии, что; в том случае, если
Unless – если не

Задание. Переведите, соблюдая правило перевода придаточных конструкций.

1. Large meetings can be productive as brainstorming sessions for ideas, provided participants can speak freely.
2. Ground can be gained in the solution to this problem, provided there is mutual desire.
3. The task of improving the living standards is quite feasible, provided all national efforts are concentrated on economic development.
4. Individuals and groups of people, who run business as a partnership, have unlimited liability for debts, unless they form a limited company.
5. Death or bankruptcy of any partner automatically dissolves the entire partnership, unless otherwise provided.
6. One of the remedies the unpaid seller can have against the buyer is an action for the contract price, provided the property in the goods has passed to the buyer.
7. Under British land laws the landholder owns the land throughout his life, unless he sells or gives it to someone else.
8. The magistrate may agree to conditional bail, that is release the suspect, provided he puts up some money as security.

9. English Courts are bound by the decisions of previous courts, unless it can be shown that the facts differ from previous cases.

10. Under the WTO system rulings are automatically adopted unless there is a consensus to reject a ruling – any country wanting to block a ruling has to persuade all other WTO members to share its view.

2.2.15. Условные предложения "If Smb Is to Do smth …", "If Smth Is to Be Done …: для Выражения Намерения

Models:

1. If we are to make inroads on crime and delinquency we must make inroads on poverty.

Если мы намерены нанести удар по организованной и детской преступности, мы должны бороться с бедностью.

2. The need for measures to protect the environment becomes more urgent every day if nature is to be preserved.

Необходимость в мерах по защите окружающей среды с каждым днем становится все более насущной, если мы хотим, чтобы (для того, чтобы) природа была сохранена.

Задание. Выполните перевод, соблюдая правило о переводе условных предложений.

1. Man-made rules are essential if the community is to work properly.
2. If the Government is to handle the problem of poverty, there are a number of measures to be urgently taken.
3. If civilization is to survive, we must cultivate the science of human relationships – the ability of people to work together at peace.
4. Science is essential if environmental concerns are to be translated into practical actions.
5. Governments had to make and enforce appropriate law, if social control was to be exercised.
6. If statutes are to fit particular cases, they need to be specially interpreted by the courts.
7. If an appeal is to be made against the judgement, it must be made within a limited period of time.
8. The applicant must satisfy a few requirements if he is to qualify for free legal aid.
9. The WTO dispute settlement agreement stresses that "prompt compliance with recommendations of the DSB* is essential if effective resolution of disputes is to be to the benefit of all Members".
10. The GATT rules are helpful in ensuring nondiscrimination, but much more is required if transaction costs are to be reduced significantly.

2.2.16. Придаточные Предложения Подлежащие (Subject Clauses) и Придаточные Предложения Сказуемые (Predicative Clauses)

Models:

I. .a) What the country needs to solve its economic problems is peace.

Мир – вот в чем нуждается страна для того, чтобы решить свои экономические проблемы.

b) What is needed is the reduction in the company’s staff.

Необходимо сокращение штата компании.

II. One principle of English contract law is that there must be offer and acceptance.

Один из принципов английского контрактного права заключается (состоит) в том, что должны существовать оферта и акцепт.

Задание. Переведите, обращая внимание на перевод придаточных предложений.

1. Whether the company could reduce its current expenses was uncertain.
2. What is needed is education and training to help people find the best solutions to their problems.
3. The question is now whether the government can start making the right decisions.
4. The basic theory of monetarists is that any change in policy that raises the money supply leads immediately to higher prices.
5. Whether the tax increase is the right solution to the budget problems is something economists have recently begun to doubt.
6. The reasons why it is hard to reform fine collecting courts is that traffic fines are a major source of income for many communities.
7. Whether a person is an employee or an independent contractor is determined by the degree of control exercised by the employing body.
8. What needs to be considered more than the nature of human rights is to whom they apply.
9. The advantage of forming a company is that it offers its members some protection in case of bankruptcy.
10. The essential difference between torts and crimes is that the former are the subject of civil law disputes between private individuals, and the latter are prosecuted by the state.
11. What is necessary in many cases is a more effective use of the United Nations as an instrument for joint political actions.
12. The separation of powers means that President and Congress are elected separately.
13. What is now required is the implementation of technology and organizational means to avoid many environmental problems.
14. The major macroeconomic argument for the past 60 years has been whether governments can effectively intervene in the business cycle.

15. How much worse things will get depends entirely on our economy.

3. ПРАКТИКА ПЕРЕВОДА НАУЧНО-ТЕХНИЧЕСКОЙ ЛИТЕРАТУРЫ

Boiler engineering

Boiler, also called Steam Generator, apparatus designed to convert a liquid to vapour. In a conventional steam power plant, a boiler consists of a furnace in which fuel is burned, surfaces to transmit heat from the combustion products to the water, and a space where steam can form and collect. A conventional boiler has a furnace that burns a fossil fuel or, in some installations, waste fuels. A nuclear reactor can also serve as a source of heat for generating steam under pressure.

Boilers were built as early as the 1st century AD by Hero of Alexandria but were used only as toys. Not until the 17th century was serious consideration given to the potential of steam power for practical work. The first boiler with a safety valve was designed by Denis Papin of France in 1679; boilers were made and used in England by the turn of the 18th century. Early boilers were made of wrought iron; as the advantages of high pressure and temperature were realized, manufacturers turned to steel. Modern boilers are made of alloy steel to withstand high pressures and extremely high temperatures.

Most conventional steam boilers are classed as either fire-tube or watertube types. In the fire-tube type, the water surrounds the steel tubes through which hot gases from the furnace flow. The steam generated collects above the water level in a cylindrically shaped drum. A safety valve is set to allow escape of steam at pressures above normal operating pressure; this device is necessary on all boilers, because continued addition of heat to water in a closed vessel without means of steam escape results in a rise in pressure and, ultimately, in explosion of the boiler. Fire-tube boilers have the advantage of being easy to install and operate. They are widely used in small installations to heat buildings and to provide power for factory processes. Fire-tube boilers are also used in steam locomotives.

In the watertube boiler, the water is inside tubes with the hot furnace gases circulating outside the tubes. When the steam turbogenerator was developed early in the 20th century, modern watertube boilers were developed in response to the demand for large quantities of steam at pressures and temperatures far exceeding those possible with fire-tube boilers. The tubes are outside the steam drum, which has no heating surface and is much smaller than in the fire-tube boiler. For this reason, the drum of the watertube boiler is better able to withstand higher pressures and temperatures. A wide variety of sizes and designs of watertube boilers are used in ships and factories. The express boiler is designed with small water tubes for quick generation of steam. The flash boiler may not require a steam drum, because the tubes operate at such high temperatures that the feed water flashes into steam and superheats before leaving the tubes. The largest units are found in the central-station power plants of public utilities. Units of substantial size are used in steel mills, paper mills, oil refineries, chemical plants, and other large manufacturing plants.

(https://www.britannica.com/technology/boiler)

Thermoelectric power generator

Thermoelectric power generator, any of a class of solid-state devices that either convert heat directly into electricity or transform electrical energy into thermal power for heating or cooling. Such devices are based on thermoelectric effects involving interactions between the flow of heat and of electricity through solid bodies.

All thermoelectric power generators have the same basic configuration, as shown in the figure. A heat source provides the high temperature, and the heat flows through a thermoelectric converter to a heat sink, which is maintained at a temperature below that of the source. The temperature differential across the converter produces direct current (DC) to a load (RL) having a terminal voltage (V) and a terminal current (I). There is no intermediate energy conversion process. For this reason, thermoelectric power generation is classified as direct power conversion. The amount of electrical power generated is given by I2RL, or VI.

A unique aspect of thermoelectric energy conversion is that the direction of energy flow is reversible. So, for instance, if the load resistor is removed and a DC power supply is substituted, the thermoelectric device shown in the figure can be used to draw heat from the “heat source” element and lower its temperature. In this configuration, the reversed energy-conversion process of thermoelectric devices is invoked, using electrical power to pump heat and produce refrigeration.

This reversibility distinguishes thermoelectric energy converters from many other conversion systems, such as thermionic power converters. Electrical input power can be directly converted to pumped thermal power for heating or refrigerating, or thermal input power can be converted directly to electrical power for lighting, operating electrical equipment, and other work. Any thermoelectric device can be applied in either mode of operation, though the design of a particular device is usually optimized for its specific purpose.

Systematic study began on thermoelectricity between about 1885 and 1910. By 1910 Edmund Altenkirch, a German scientist, satisfactorily calculated the potential efficiency of thermoelectric generators and delineated the parameters of the materials needed to build practical devices. Unfortunately, metallic conductors were the only materials available at the time, rendering it unfeasible to build thermoelectric generators with an efficiency of more than about 0.5 percent. By 1940 a semiconductor-based generator with a conversion efficiency of 4 percent had been developed. After 1950, in spite of increased research and development, gains in thermoelectric power-generating efficiency were relatively small, with efficiencies of not much more than 10 percent by the late 1980s. Better thermoelectric materials will be required in order to go much beyond this performance level. Nevertheless, some low-power varieties of thermoelectric generators have proven to be of considerable practical importance. Those fueled by radioactive isotopes are the most versatile, reliable, and generally used power source for isolated or remote sites, such as for recording and transmitting data from space.

Major Types Of Thermoelectric Generators

Thermoelectric power generators vary in geometry, depending on the type of heat source and heat sink, the power requirement, and the intended use. During World War II, some thermoelectric generators were used to power portable communications transmitters. Substantial improvements were made in semiconductor materials and in electrical contacts between 1955 and 1965 that expanded the practical range of application. In practice, many units require a power conditioner to convert the generator output to a usable voltage.

Fossil-fuel generators

Generators have been constructed to use natural gas, propane, butane, kerosene, jet fuels, and wood, to name but a few heat sources. Commercial units are usually in the 10- to 100-watt output power range. These are for use in remote areas in applications such as navigational aids, data collection and communications systems, and cathodic protection, which prevents electrolysis from corroding metallic pipelines and marine structures.

Solar-source generators

Solar thermoelectric generators have been used with some success to power small irrigation pumps in remote areas and underdeveloped regions of the world. An experimental system has been described in which warm surface ocean water is used as the heat source and cooler deep ocean water as the heat sink. Solar thermoelectric generators have been designed to supply electric power in orbiting spacecraft, though they have not been able to compete with silicon solar cells, which have better efficiency and lower unit weight. However, consideration has been given to systems featuring both heat pumping and power generation for thermal control of orbiting spacecraft. Utilizing solar heat from the Sun-oriented side of the spacecraft, thermoelectric devices can generate electrical power for use by other thermoelectric devices in dark areas of the spacecraft and to dissipate heat from the vehicle.

Nuclear-fueled generators

The decay products of radioactive isotopes can be used to provide a high-temperature heat source for thermoelectric generators. Because thermoelectric device materials are relatively immune to nuclear radiation and because the source can be made to last for a long period of time, such generators provide a useful source of power for many unattended and remote applications. For example, radioisotope thermoelectric generators provide electric power for isolated weather monitoring stations, for deep-ocean data collection, for various warning and communications systems, and for spacecraft. In addition, a low-power radioisotope thermoelectric generator was developed as early as 1970 and used to power cardiac pacemakers. The power range of radioisotope thermoelectric generators is generally between 10−6 and 100 watts.

Principles Of Operation

An introduction to the phenomena of thermoelectricity is necessary to understand the operating principles of thermoelectric devices.

Seebeck effect

In 1821 the German physicist Thomas Johann Seebeck discovered that when two strips of different electrically conducting materials were separated along their length but joined together by two “legs” at their ends, a magnetic field developed around the legs, provided that a temperature difference existed between the two junctions. He published his observations the following year, and the phenomenon came to be known as the Seebeck effect. However, Seebeck did not identify the cause of the magnetic field. This magnetic field results from equal but opposite electric currents in the two metal-strip legs. These currents are caused by an electric potential difference across the junctions induced by thermal differences between the materials. If one junction is open but the temperature differential is maintained, current no longer flows in the legs but a voltage can be measured across the open circuit. This generated voltage (V) is the Seebeck voltage and is related to the difference in temperature (ΔT) between the heated junction and the open junction by a proportionality factor (α) called the Seebeck coefficient, or $V = \alpha\Delta T$. The value for α is dependent on the types of material at the junction.

Peltier effect

In 1834 the French physicist and watchmaker Jean-Charles-Athanase Peltier observed that if a current is passed through a single junction of the type described above, the amount of measured heat generated is not consistent with what would be predicted solely from ohmic heating caused by electrical resistance. This observation is called the Peltier effect. As in Seebeck’s case, Peltier failed to define the cause of the anomaly. He did not identify that heat was absorbed or evolved at the junction depending on the direction of the current. He also did not recognize the reversible nature of this thermoelectric phenomenon, nor did he associate his discovery with that of Seebeck.

Thomson effect

It was not until 1855 that William Thomson (later Lord Kelvin) drew the connection between the Seebeck and Peltier effects, which was the first significant contribution to the understanding of thermoelectric phenomena. He showed that the Peltier heat or power (Qp) at a junction was proportional to the junction current (I) through the relationship $Qp = \pi I$, where π is the Peltier coefficient. Through thermodynamic analysis, Thomson also showed the direct relation between the Seebeck and Peltier effects, namely that $\pi = \alpha T$, where T is the temperature of the junction. Furthermore, on the basis of thermodynamic considerations, he predicted what came to be known as the Thomson effect, that heat power ($Q\tau$) is absorbed or evolved along the length of a material rod whose ends are at different temperatures. This heat was shown to be proportional to the flow of current and to the temperature gradient along the rod. The proportionality factor τ is known as the Thomson coefficient.

Analysis of a thermoelectric device

Practically, the thermoelectric property of a device is adequately described using only one thermoelectric parameter, the Seebeck coefficient α. As was shown by Thomson, the Peltier coefficient at a junction is equal to the Seebeck coefficient multiplied by the operating junction temperature. The Thomson effect is comparatively small, and so it is generally neglected.

While there is a Seebeck effect in junctions between different metals, the effect is small. A much larger Seebeck effect is achieved by use of p-n junctions between p-type and n-type semiconductor materials, typically silicon or germanium. The figure shows p-type and n-type semiconductor legs between a heat source and a heat sink with an electrical power load of resistance RL connected across the low-temperature ends. A practical thermoelectric device can be made up of many p-type and n-type semiconductor legs connected electrically in series and thermally in parallel between a common heat source and a heat sink. Its behaviour can be discussed considering only one couple.

An understanding of the thermal and electric power flows in a thermoelectric device involves two factors in addition to the Seebeck effect. First, there is the heat conduction in the two semiconductor legs between the source and the sink. The thermal flow down these two legs is given by

$2\kappa(a/L)\Delta T$,

where κ is their average thermal conductivity in watts per metre-kelvin, a (or w2) is the area in square metres of the base of each leg, L is the length of each leg in metres, and ΔT is the temperature differential between source and sink in kelvins. The second factor is the ohmic heating that occurs in both of the legs because of electrical resistance. The heat power produced in each leg is given by

$\rho I2(L/a)$,

where ρ is the average electrical resistivity of the semiconductor materials in ohm-metres and I is the electric current in amperes. Approximately half of the resistance-produced heat in each of the two legs flows toward the source and half toward the sink.

In a thermoelectric power generator, a temperature differential between the upper and lower surfaces of two legs of the device can result in the generation of electric power. If no electrical load is connected to the generator, the applied heat source power results in a temperature differential (ΔT) with a value dictated only by the thermal conductivity of the p- and n-type semiconductor legs and their dimensions. The same amount of heat power will be extracted at the heat sink. However, because of the Seebeck effect, a voltage $V\alpha = \alpha\Delta T$ will be present at the output terminals. When an electrical load is attached to these terminals, current will flow through the load. The electrical power generated in the device is equal to the product of the Seebeck coefficient α, the current I, and the temperature differential ΔT. For a given temperature differential, the flow of this current causes an increase in the thermal power into the device equal to the electric power generated. Some of the electric power generated in the device is dissipated by ohmic heating in the resistances of the two legs. The remainder is the electrical power output to the load resistance RL.

The leg geometry has a considerable effect on the operation. The thermal conduction power is dependent on the ratio of area to length, while ohmic heating is dependent on the inverse of that ratio. Thus, an increase in this ratio increases the thermal conduction power but reduces the power dissipated in the leg resistances. An optimum design normally results in relatively long and thin legs.

In choosing or developing semiconductor materials suitable for thermoelectric generators, a useful figure of merit is the square of the Seebeck coefficient (α) divided by the product of the electrical resistivity (ρ) and the thermal conductivity (κ).

(https://www.britannica.com/technology/thermoelectric-power-generator)

Combined Heat and Power (CHP)

Combined heat and power (CHP) systems, also known as cogeneration, generate electricity and useful thermal energy in a single, integrated system. CHP is not a technology, but an approach to applying technologies. Heat that is normally wasted in conventional power generation is recovered as useful energy, which avoids the losses that would otherwise be incurred from separate generation of heat and power. While the conventional method of producing usable heat and power separately has a typical combined efficiency of 45 percent, CHP systems can operate at levels as high as 80 percent.

Conventional generation is inherently inefficient, only converting on average about a third of the input fuel's potential energy into usable energy. Engineers have long appreciated the tremendous efficiency opportunity of combining electricity generation with thermal loads in buildings and factories, capturing much of the energy that would otherwise be wasted. When the word "cogeneration" was coined in the 1970s to describe this practice, the dominant configuration of systems was a boiler that generated steam, some of which was used to turn a steam turbine that generated electricity. Due to the cost and complexity of these systems, they were largely confined to systems of over 50 MW, thus precluding their installation at most manufacturing facilities. However, recent advances in electricity-efficient, cost-effective generation technologies—in particular advanced combustion turbines and reciprocating engines—have allowed for new configurations of systems that combine heat and power production, expanding opportunities for these systems and increasing the amount of electricity they can produce. These CHP systems now come in many more configurations, and can even satisfy compressed air requirements by bleeding high-pressure air off the compressor stage of a combustion turbine.

New turbines are now cost effective for systems down to 500 kW and reciprocating engines for systems down to 50 kW, dramatically expanding the number of sites where CHP can be installed. In fact, many existing industrial boilers can be re-powered with advanced generation equipment, replacing existing fuel burners and adding electricity generation capability while reducing pollutant emissions.

New generations of turbines and reciprocating engines are the result of an intensive collaborative research by government and industry that uses advanced materials and computer-aided design techniques that have dramatically increased equipment efficiency and reliability while reducing costs and pollutant emissions.

These technologies, applied in CHP, are poised to satisfy a significant portion of the U.S.'s growing electricity needs, while continuing to meet our thermal demands. According to a 2012 joint report from the U.S. Department of Energy and U.S. Environmental Protection Agency (EPA), CHP currently makes up about 8 percent of U.S. total generating capacity. The present installed capacity of CHP in the U.S. is about 82 GW, and the Obama administration has set an official goal of 40 GW of additional CHP capacity by 2020. Additionally, as the U.S. EPA establishes new rules to reduce CO2 from power plants, CHP has been identified as a critical tool to reduce CO2 cost-effectively.

Several barriers impede the full realization of the country's CHP potential. These include electric utility rate structures that discourage utility investment in CHP, a lack of common and fair interconnection andnet metering standards, discriminatory utilitystandby rates, and emissions regulations that do not recognize the improved efficiency and pollution benefits of CHP systems.

(https://www.britannica.com)

MAN Energy hands over new CHP plant in Germany

New combined heat and power technology has replaced coal-fired operations at a power plant in Germany.

The plant operator, EnBW Energie Baden-Württemberg, have overseen a significant modernization programme at the plant's HKW3 unit.

This project saw Germany technology company MAN Energy Solutions install three of its MAN 20V35/44G gas engines, which produce not only electrical energy but also 30 MW of district heating.

In addition to the CHP plant, EnBW has also constructed a heat storage and a boiler plant with up to 175 MW thermal energy output to cover fluctuations in supply and demand. The existing coal power plant was decommissioned in December.

Jens Rathert, Project Manager at EnBW, said: "The reconstruction of HKW3 is part of EnBW's strategy for the energy transition, replacing an existing coal-fired plant with a modern gas-powered CHP and boiler plant. By doing this, we are significantly reducing the emissions of CO2 and other pollutants, which is particularly important given the urban surroundings of the power plant. Looking at the bigger picture of the energy transition, we regard facilities like the HKW3 as a blueprint for further fuel-switch projects and relish the opportunity for more projects along these lines."

The CHP plant is a core element of the new construction: While gas boilers produce exclusively heat and are primarily designed to cover the peaks in demand over winter, the gas engines will ideally be run continually to provide both electricity and heat.

By combining the facility with a district heating accumulator, EnBW said it can fully utilize the flexibility offered by the engines and react to price signals. When demand for heat is low, the waste heat from the engines can be stored. This flexibility is made possible by the high reaction speed of the MAN gas engines, which reach their full output in less than five minutes and can handle load changes with ease.

Dr. Tilman Tütken, Vice President of the power plant division of MAN Energy Solutions, said: "Large gas engine power plants are a new but important technology in Germany. They help to reduce harmful emissions and guarantee an extremely reliable supply.

"Gas engine power plants have the potential to replace coal power stations in a way that is not only effective but better for the environment. Our modular power plant concept for cogeneration is being brought to fruition in Stuttgart Gaisburg. The concept works on the modular principle and can be scaled up as required from 7 MW."

(https://www.powerengineeringint.com/articles/2019/02/man-energy-hands-over-new-chp-plant-in-germany.html)

Integrating renewables into a reliable power ecosystem

Balancing renewables represents the most efficient and sustainable approach to meeting the energy needs we have now, and those of the next generation. Efficient control hardware combined with the management and optimization offered by virtual power plants provides an opportunity to meet that challenge today.

The evolution of control software and electrical hardware solutions for renewable and distributed power generation are two major drivers for potential improvement in energy efficiency in the power industry.

Combined solutions such as Virtual Power Plants move the concept on further again: they can be used to support the transition from traditional energy generation to renewables by offsetting some of the constraints and variability experienced with green power sources.

Given recent trends in the power generation sector and our corporate philosophy of contributing to a greener tomorrow, we have intentionally focused on control and electrical solutions for renewable and distributed power generation.Integrating renewables into a reliable power ecosystem with virtual power plants

These are two major drivers for improved generating and operational energy efficiency in the power sector. Over recent decades, we have engineered successful products and projects for energy from waste (EfW), combined heat and power (CHP) as well as combined cold, heat and power plants; helping them become the most efficient sources of energy generation and transformation they can be.

The other aspect of our contribution towards energy efficiency lies in how our solutions help end users and small generators to operate more efficiently.

Whereas one category of customer includes energy producers, the other also contains energy consumers. With our integrated automation and electrical solutions, we aim to enable both categories to operate with the highest levels of energy efficiency.

We set out to help power producers and consumers to optimize their internal consumption by offering them more efficient and reliable process control options, as well as electrical balance of plant, solutions.

Are virtual power plants part of Industry 4.0?

The Virtual Power Plant (VPP) concept wasn't consciously developed as an Industry 4.0 solution. It is more, one of many evolutions in the automation and data processing path which coincides with within the arena of Industry 4.0. That said, energy management and monitoring, and Industry 4.0 should not be judged as occupying two mutually exclusive spaces.

There has been and will always be the need for energy management and monitoring. The quality and capabilities of that functionality however are subject to continuous enhancement with further developments in data sensing, measuring, transmitting and processing technologies.

The pace of this development has been exponential in the last few years preparing the ground to create more value-added solutions like Virtual Power Plants. The catch word for this last phase of development is Industry 4.0 these days.

The transition to renewables

We believe Virtual Power Plants can to a great extent support the transition from traditional energy generation to renewables. Renewable energies, despite all their indisputable advantages do also come with considerable disadvantages, limiting the net benefit for some end users. Integrating renewables into a reliable power ecosystem with virtual power plants

For most users, individual renewable energy sources are quite inflexible, you have power when there is sun shining or the wind blowing, but your energy consumption patterns do not necessarily follow the sun or wind.

Secondly, their availability is not fully predictable - just imagine the situation when you have a blanket dust storm in a desert where you have installed hundreds of megawatts of solar power.

Renewable energies are of course the most environmentally friendly sources of power and are becoming cheaper to produce as well. But every professional in the power industry knows, when it comes to power, reliability of supply comes first.

This was for a while where conventional power had a dominant position, flexibility. Our Virtual Power Control however makes a combination of renewable energies flexible too and therefore makes them a secure source of power supply. This is done by coordinating the most economical and available energy generation and storage sources to meet a certain load at any point of time. This remove a major barrier to maximizing renewable integration on the grid.

Is blockchain technology relevant?

Blockchain technology is a current hot topic and does have the potential to contribute tremendously to a transition by the power sector from a conventional centrally controlled system to a distributed and yet secure power matrix.

Since in a blockchain there is no central data storage and processing location, there are no copies, there is one single entity of any specific block of data which is distributed between different participating nodes. This unique feature can increase the robustness of the control and data processing system to outside cyber threats as one needs to copy the entire distributed system to be able to manipulate it.

So, blockchain technology can potentially be used to address the biggest concern of policy makers and regulators with respect to vulnerability of the power systems of the future to cyber-attacks. However, I must also issue a word of caution and say we are at the early stages of exploring how blockchain can be used in our industry. We should take the time and test solutions before speculating too much about the outcomes.Morteza Seraj, Director Process Automation, Factory Automation EMEA, Mitsubishi Electric Europe B.V.

The combination of currently available technology has the potential to make far reaching improvements to overall energy efficiency, both from a generation capacity and distribution point of view. The application of the latest automation controllers, power management equipment and software solutions, including combination systems such as Virtual Power Plants, can be used to integrate diverse power sources and optimize our power landscape.

(https://www.powerengineeringint.com/articles/2019/05/industry-opinion-integrating-renewables-into-a-reliable-power-ecosystem.html)

Promising results from carbon capture project for biomass CHP plants

A new research project is studying the feasibility of using carbon capture technology at biomass CHP plants in Denmark.

The project is a collaboration between Danish engineering, design and consultancy company Ramboll**,** theGeological Survey of Denmark and Greenland (GEUS), Technical University of Denmark (DTU) and SINTEF Energy Research.

Previous attempts at implementing carbon capture and storage at CHP plants have been abandoned, not least because the technology has been too expensive.

But now the four research partners are underway with a techno-economic study of the feasibility of a future integrated CO_2-neutral energy system, where the subsurface is utilized for thermal energy supply and storage, as well as temporary CO_2 storage.

“The study looks very promising so far, and the technology used seems to be technically feasible for major CHP plants based on biomass, and with heat recovery for district heating, the economic feasibility has improved dramatically”, said Ramboll engineer Thomas Paarup Pedersen, who is part of the core research team.

The study analyses a generic bio-plant retrofitted with a CO_2 capture. The generic bio-plant is benchmarked against a reference power plant, the biomass-fired Avedøre 1 CHP plant, located in the outskirts of Copenhagen. The plant has a capacity of 640 MWth, with net electric power output of 219 MW and district heating production of 352 MWth at full-load conditions. The plant operates with 100 per cent wood pellets.

Ramboll said the Avedøre plant is considered representative of a state-of-the-art power plant that has been converted from operating with coal to biomass.

In the modelling work, the bio-plant is retrofitted with so-called Monoethanolamine (MEA) capture technology, a well-known carbon capture technique of CO_2 absorption by using amines. In the process, steam from the CHP production is used to regenerate the amine used to capture CO_2.

When leaving the capture plant, the CO_2 is compressed to 110 bar, transported by pipeline 3 km towards northeast, and injected into a storage reservoir which is 1300 metres deep. 30 years injection of 1 million tonnes/year of CO_2 is feasible from one

injection well. The transport and injection case is based on capture from Nordjyllandsværket CHP plant after possible conversion to biomass-firing.
The research partners say that so far the results show that it is possible to recover a considerable amount of heat from the capture process for use in the district heating system, significantly improving the thermal efficiency of the bio-plant and consequently reducing the cost of CO_2 capture by roughly 30 per cent, or from €77 to €52 per tonne of CO_2 captured.
In Denmark, 30 per cent of all energy consumed comes from renewables, and the country intends to increase this to 50 per cent by 2030 with the long-term goal of becoming a low-emission country, independent of fossil fuels by 2050.
(https://www.powerengineeringint.com/articles/2019/06/promising-results-from-carbon-capture-project-at-chp-plant.html)

UK engineers outline transition path to hydrogen

The UK's leading engineering bodies have jointly agreed that it should be possible to safely replace natural gas with hydrogen for domestic and industrial energy use.
"We are now in a position to seriously consider the viability of using hydrogen in the UK's gas grid for homes and businesses, which could significantly contribute to the decarbonization of the UK's energy sector," said Dr Robert Sansom of the Institution of Engineering and Technology (IET).
The IET led a study which also included the Health and Safety Laboratory plus the engineering institutions for Chemical Engineers, Mechanical Engineers, and Gas Engineers and Managers. They were tasked by the UK government to assess the engineering risks and uncertainties around using hydrogen in homes, businesses and industry, and they have now published the results of their investigations in a research study.
In the UK, natural gas accounts for 85 per cent of domestic heating and cooking, more than 50 per cent of energy consumed by industry, as well as 40 per cent of Britain's electricity.
In the new study, 'Transitioning to hydrogen – Assessing engineering risks and uncertainties', the engineers stress that "the key feature of hydrogen is that when combusted it produces no carbon emissions and is therefore a low carbon alternative to natural gas".
Dr Sansom of the IET's energy policy panel said: "Hydrogen has not been deployed at scale anywhere in the world and so any proposal will need to compensate for this lack of experience.
"Our report identifies key risks and uncertainties, such as ensuring that we understand the impact on the public from a transition to hydrogen and can minimise any disruption that arises.
"We know hydrogen produces no carbon emissions when burned, but it is also important to fully investigate and understand the overall environmental impact a switch to hydrogen is likely to make."

He stressed that “it is fundamental that these areas as well as others identified in the report are comprehensively addressed before a programme of large-scale deployment is considered”.
The report highlights that one of the benefits of hydrogen is its ability to be produced in large volumes from natural gas using a process called gas reforming. However, a by-product of this process is carbon dioxide and the study calls for a committed infrastructure plan for carbon capture, utilisation and storage.
The report points out that while hydrogen can also be produced using electrolysis, at present, this is less suited for producing large volumes of hydrogen and costs are currently higher.
The engineers also highlight that to enable any roll-out of hydrogen, most of the UK’s iron mains gas networks will have to be replaced with hydrogen-safe polyethylene pipes by 2030.
Existing gas boilers in homes will also need to be replaced – but the report points out that boilers have a working life of 10 to 15 years and therefore, these could be phased in with ‘hydrogen-ready’ boilers at little additional cost to consumers.
Dr Sansom acknowledged that a switch to hydrogen was ambitious. “To make a significant contribution to meeting the UK’s 2050 carbon reduction target, the transition to hydrogen would need to be implemented over the next 30 years. This may seem a long time – but in terms of the infrastructure required and millions of homes and businesses affected, it is relatively short. Action is required now and we hope that our findings and subsequent recommendations can make a significant contribution to advancing the decarbonization of the UK.”
(https://www.powerengineeringint.com/articles/2019/06/uk-engineers-outline-transition-path-to-hydrogen.html)

Siemens inaugurates world’s largest electrothermal energy storage system

A 'milestone' electric thermal energy storage system operated by Siemens Gamesa Renewable Energy is now operational.
The heat storage facility is located in Hamburg-Altenwerder in Germany and contains around 1000 tonnes of volcanic rock as an energy storage medium.
It is fed with electrical energy converted into hot air by means of a resistance heater and a blower that heats the rock to 750°C. When demand peaks, electric thermal energy storage (ETES) uses a steam turbine for the re-electrification of the stored energy. The ETES pilot plant can thus store up to 130 MWh of thermal energy for a week. In addition, the storage capacity of the system remains constant throughout the charging cycles.
The aim of the pilot plant is to deliver system evidence of the storage on the grid and to test the heat storage extensively. In a next step, Siemens Gamesa plans to use its storage technology in commercial projects and scale up the storage capacity and power. The goal is to store energy in the range of several gigawatt hours in the near future - 1 GWh is the equivalent to the daily electricity consumption of around 50,000 households.

"With the commissioning of our ETES pilot plant, we have reached an important milestone on the way to introducing high-performance energy storage systems," said Markus Tacke, Siemens Gamesa Renewable Energy chief executive.
"Our technology makes it possible to store electricity for many thousands of households at low cost. We are thus presenting an elementary building block for the further expansion of renewable energy and the success of the energy transition."
The technology reduces costs for larger storage capacities to a fraction of the usual level for battery storage.
The Institute for Engineering Thermodynamics at Hamburg University of Technology and the local utility company Hamburg Energie are partners in the innovative Future Energy Solutions project, which is funded by the German Federal Ministry of Economics and Energy.
Hamburg Energie is responsible for marketing the stored energy on the electricity market. The energy provider is developing highly flexible digital control system platforms for virtual power plants, it said. Connected to such an IT platform, ETES could optimally store renewable energy at maximum yield, said Siemens.
(https://www.powerengineeringint.com/articles/2019/06/siemens-inaugurates-world-s-largest-electrothermal-energy-storage-system.html)

Bridging the renewables gap - What role can gas hybrids play?

While the energy landscape seemed frozen in time for several decades from the 1950s until 2000, we have certainly come out of the ice age and are now headed, perhaps a little too quickly, to much warmer times.
Awareness of the impact of global warming has led to an acceleration of the change to the energy sector which has been compared to the changes seen in the great industrial revolution of the 18th and 19th centuries.
With this, the advent of intermittent renewables has ushered in a brand-new set of challenges that stakeholders had never faced before. Technologies and sources of energy glorified one day, fall out of grace the next day. Gas power is one of those, but as I will argue, there is a way that we can bring it back into favour: the intelligent deployment of battery storage.The Gold Fields Granny Smith gold mine in Western Australia is to install one of the world's largest renewable microgrids
A much cleaner fuel than coal or liquid fossil fuels, gas quickly rose to the top of the energy mix in many countries in the millennium. Combined-cycle gas turbines became the most popular form of centralised electricity generation, driven by the low cost of gas and their high efficiency. This is borne out in figures from Bloomberg New Energy Finance (BNEF), which show that between 2008 and 2015, 250 GW of new gas capacity was installed across about 2000 sites worldwide.
However, as the need for flexible generation increased due to rising volume of solar and wind power installations, CCGT got into trouble; although efficient, they are not able to move fast enough to compensate for the variations in supply associated with renewables. So the sector responded with more gas technology: fast-acting open cycle gas turbines (OCGT) came back into fashion.

This presented new challenges when it came to the integration of renewables. Firstly, the marginal cost of renewables production is effectively zero, leading renewables to compete strongly with CCGT on wholesale electricity markets, thereby displacing the cleanest thermal generation of the system. Secondly, the increase in renewables led to an increased demand for fast responding OCGTs which could keep up with the associated intermittency but were also less efficient than CCGTs.

In short, the most efficient form of gas generation was being displaced by renewables combined with much less efficient OCGT gas turbines.

Surely we can do better?

The answer comes in the form of energy storage. The price of batteries has dropped considerably in the past 10 years – according to BNEF the price of battery cell packs have dropped from almost $1200 in 2010 to less than $200 in 2018. Batteries are now a more competitive (and cleaner) alternative to OCGT, which is now being recognised in legislation.

For example, California's two landmark energy storage bills require California's Investor-Owned Utilities (IOUs) to procure and install nearly 2 GW of storage by 2024. The assessment carried out by the state government of the cost vs benefits of batteries compared with gas turbines has found batteries to be more economical.

Centralised electricity generation seems to have also found its stride. We now have higher levels of renewables than ever before, enabled by grid-scale energy storage and efficient thermal generation thanks to the use of gas as a controllable baseload power.

At Aggreko, we believe the lessons learned from centralised power generation can be applied to distributed generation to provide our customers, wherever they are, with the best balance of clean, cheap and reliable power. Our 'CCGT' is our fleet of gas engines; our storage technology is our new Y.Cube, a fully containerised 1 MW battery; and the grid operator is our smart YQ energy management system.

There are a range of examples where we have seen this work across the world. The Gold Fields Granny Smith gold mine in Western Australia is set to install one of the world's largest renewable energy microgrids. It will be powered by a combination of gas generators and 20,000 solar panels and supported by the Y.Cube battery system. The use of battery storage will enable the mine operators to use more solar while also running gas engines more economically.

Gold Fields is just the beginning. In many in off-grid locations the right combination of gas, batteries and solar is already the most economically attractive technology mix.

Gas-battery hybrids have an even wider application than remote off-grid projects. Access to reliable power can also be an issue in countries with a reliable electricity system. Data centres for example are often built faster than the grid can keep up with; on top of that the computers in each centre are also extremely sensitive to power quality and can require very sudden spikes in demand.

We have helped our customers who run data centres to meet this challenge by supplying one such centre in Ireland with gas generators and a battery, guaranteeing both a stable energy supply and the highest possible power quality. It also provides an easy-to-implement and reliable solution to keep the business running.

Huge strides have been made in the past few years to establish greener power solutions as a source of energy. However, the energy transition is far from complete. New technologies keep emerging, and there is still little knowledge of what the end point will look like and how long it will take to reach it.
But despite all the uncertainty there are some things we do know. One is that combining batteries with gas will go a long way to making cheaper, cleaner and more reliable power more accessible.
(https://www.powerengineeringint.com/articles/2019/06/industry-opinion-can-batteries-give-gas-generation-a-second-chance.html)

Women in engineering: Inspiring the female future

On 23 June 1919, a committee of influential women sensed a new dawn. The First World War had ended, and significant steps had been taken towards women's suffrage.
The group, ranging from designers and munitions factory managers to wives of eminent engineers, rallied to found the Women's Engineering Society (WES).Only 11 per cent of the UK's engineers are female
One hundred years later, progress for women in industry has often felt stagnant. As we celebrate the centenary of the Women's Engineering Society and International Women in Engineering Day on June 23, the fact that only 11 per cent of the UK's engineers are female is a tough pill to swallow.
The Society's initial journal outlined its aims to "encourage and stimulate all women who are interested in engineering", but today's figures show that it's often hard to see these efforts come to fruition. So, what can be done to nurture talent in this milestone year?
The state of industry
The UK has the lowest percentage of female engineers in Europe. As it stands, this figure isn't set to rise any time soon. It's estimated that less than eight per cent of engineering and manufacturing apprentices are female, with figures plunging to as low as two per cent in the building and construction sector.
But the UK needs to significantly increase its number of engineers. The STEM skills shortage is costing businesses £1.5bn in recruitment every year. For the engineering sector to reduce its skills shortage, it needs to employ around 186,000 recruits each year until 2024.
To inspire the future, we should reflect on the past. A lack of role models is often cited as a reason why women shy away from a career in this industry. However, the reality is that our engineering heroines are often unsung.
The pressures of war drew many women to the home front, only for them to experience rebuke once men returned. In resistance, the founders of WES created a committee that promotes engineering as a rewarding profession for women as well as men.
The original members of the group paved the way for women in industry. Renowned for her adventures as a pilot, Amy Johnson was a qualified engineer and WES

president from 1933-34. Johnson's campaigning inspired others such as Dorothy Spicer, another society member and the first person to hold all four types of aeronautic licenses.

Whether it's a female Doctor Who at the helm of the Tardis, or a woman encouraging the next generation of engineers, prominent role models need to be realised as figures of inspiration.

Striking the balance

If we are to progress, we must strive for a more balanced workforce that reflects the diversity of our society and invests in the development of all talented workers.

McKinsey's Delivering Through Diversity report states that many companies struggle to increase the representation of diverse talent and create truly inclusive organisational cultures to profit from diversity.

Yet data from 2017 found that companies in the top-quartile for gender diversity on their executive teams were 21 per cent more likely to have above-average profitability than companies in the fourth quartile. To address the skills gap and boost productivity, companies need to act to diversify.

International Women in Engineering Day takes place on June 23. To encourage women to pursue a career in engineering, action has to begin as early as possible.

Professor Karen Holford, Deputy Vice Chancellor at Cardiff University and voted one of WES's most influential female engineers in 2016 explains that "the stumbling blocks are there from a very young age, such as girls not being given toy trains and cars to play with. It may sound like a small thing, but unconscious stereotyping is still holding girls back, without them even realising it.

"Schools must ensure that teachers have the critical skills to teach the subjects needed for a career in engineering. Finally, companies need to do more to promote flexible working for both men and women. This way we can ensure that the burden of childcare is equally shared so that women aren't out of the workplace for long periods. If we can solve these problems, I believe we'll see a big increase in women choosing engineering careers and, even better, staying in them."

(https://www.powerengineeringint.com/articles/2019/06/women-in-engineering-inspiring-the-female-future.html)

Running transformers in extreme climates

A focus on some of the world's most extreme transformer environments and what they can teach us for everyday applications

The world's first liquified natural gas project within the Arctic Circle, the $27 billion Yamal facility, sits on permafrost in a region where temperatures can fall past -50oC.

Such extreme conditions pose many engineering challenges, not least those relating to the 20 or so power transformers charged with keeping the project running.

Transformers are critical pieces of equipment, required to reliably operate in some of the world's most extreme environments. This has led to engineering innovations to help them operate safely and effectively under a wider range of operating situations, such as the use of synthetic ester fluids in place of mineral oil. Just as yesterday's

Formula One tech influences today's commuter cars, there are lessons here we can apply to more mainstream environs in future.
And it's vital that lessons are learned: because tomorrow's normal may well be more extreme than todays. As the Intergovernmental Panel on Climate Change's latest report warns, climate change will "significantly worsen the risks of drought, floods, extreme heat and poverty", and as the frequency and severity of extreme weather events increases and urbanisation ups the stakes in terms of transformer safety risks, extreme may well become more every day.

Frozen fluids

In the case of Yamal LNG, a synthetic ester fluid with a pour point of -56oC was used to mitigate freezing and fire risks; with higher flash and fire points, an external fault would be far less likely to lead to a failure or fire, therefore reducing the chances and potential severity of an incident, in a location where billions of dollars of investment have been made.
It's not just the Arctic Circle where this is an issue; wind turbines in locations such as Canada, Northern China and the North Sea also suffer from the cold. Owing to the intermittent nature of renewable energy, there is increased risk of freezing when the turbine isn't running. Using an ester fluid with a very low pour point would then help with "cold starting" the transformer when the turbine is energised.
Conversely, synthetic esters offer equal advantages in the opposite extreme. Consider Kuwait, where the mercury behaves quite differently than in Yamal, with ambient air temperatures rarely dipping below 50oC in the summer months. In fact, engineers design transformers assuming 58oC.
This is the air being used to cool the equipment. In practice, once it has been taken into the transformer, it is probably closer to 70oC. As such, you have assets running very close to their maximum permitted temperature. If any faults occur that restrict liquid flow – causing hot spots in the transformer – then localised overheating can happen.
That's when mineral oil transformers explode and burn – a phenomenon known in Kuwait as 'popping'. With a fire point considerably exceeding that of mineral oil, synthetic esters again mitigate the safety and financial risk of failure. However, there are also additional benefits in terms of reduced maintenance costs, as the extreme heat accelerates chemical reactions that cause degradation. The use of an ester fluid could potentially compound cost savings on auxiliary cooling equipment that would otherwise be needed. In the midst of this extreme environment, the Kuwaitis have proactively embraced risk mitigation and adopted synthetic ester transformer fluids on a national basis.

Deepsea dangers

Not all transformers are air-cooled though. Some aren't even exposed to air at all. Subsea transformers are used in powering subsea oil and gas facilities (and perhaps renewables in future) and though fire risk isn't an issue, this gives two key requirements.
First, the transformer fluid must stand up to extreme pressure without changing properties. Second, it must be environmentally benign and non-toxic in case of leaks.

Biodegradable synthetic esters are used in transformers up to five kilometres below sea level to deliver exactly these solutions.

From deep below sea-level, to the slopes of your favourite ski resort: altitude also poses challenges for transformer design. Despite the usual association with cold, air-cooled, high altitude transformers are actually at increased risk of overheating. The thinner air is less effective at transferring heat away from the transformer, meaning the increased fire protection of ester fluids are ideal.

Another major risk to transformers is water ingress. As such, extremely humid environments are challenging for transformers. Here, unless the maintenance regime is absolutely flawless, there is a high chance that water will enter the transformer. Transformer fluids all have a moisture saturation point, up to which they can absorb the water without problem. However, while esters offer a saturation point of 2700mg/kg, mineral oil can only manage 55mg/kg.

This problem is exacerbated in humid environments that also threaten extreme swings in temperature, such as during tropical rainstorms. As the liquid cools, its saturation point falls, meaning it may expel water that had been absorbed earlier at warmer temperatures.

Extreme weather

Extremity isn't only about ambient characteristics though, it can also be seen in the increased frequency of extreme weather events. Though choice of ester fluid won't contribute to a transformer's ability to withstand a hurricane's onslaught, for example, it can offer a significant boost to environmental and societal resilience.

Firstly, as a more fire-safe fluid, esters offer a degree of protection where storms or flooding cause electrical faults within the transformer. Secondly, as a non-toxic, biodegradable option, if the transformer is damaged and leaks, the environment is protected.© Siemens

However, ester fluids also contribute to resilience in other ways. New York utility Con-Ed has invested in a mobile 'resilience' transformer. Made by Siemens, this is small enough to be loaded on a flatbed and moved quickly to blackout sites to restore power in days rather than weeks or months. This is possible as, by enabling operation at higher temperatures, ester fluids reduce the necessary size and weight of the transformer. The concept of making and deploying smaller transformers is growing in popularity and promises to be a real-world growth trend.

Climate change is upon us and the experts tell us to expect more of these types of extreme weather events. But for many, everyday environments will become more extreme too. The UK's Met Office warns that climate change will mean that conditions such as the summer heatwave of 2018 become more frequent in future. Though uncomfortable in the UK, in Spain temperatures peaked above 45oC and northern Europe saw forest fires rage out of control, as did California and Australia.

At the same time, urbanisation and ever denser built environments are upping the strain placed on transformers and increasing the demands on infrastructure. Utilities will find that it becomes more important than ever to find ways to build resilience into their assets. As the extreme becomes more everyday and the everyday more extreme, today's best practice will be tomorrow's standard practice.

(https://www.powerengineeringint.com/articles/2018/12/feature-running-transformers-in-extreme-climates.html)

CFB technology in a low carbon world

How does CFB boiler technology sit in an energy landscape that is looking for renewable and low carbon solutions?

Last year Sumitomo Heavy Industries acquired Amec Foster Wheeler's fluidized bed businesses, creating a new company, Sumitomo SHI FW.

We spoke to Robert Giglio, Senior Vice-President of Strategic Business Development for Sumitomo SHI FW, about the acquisition, the market potential for CFB boiler technology, and how it fits into an energy world that is increasingly looking for low carbon solutions.

Q: Why was the acquisition a good fit for both companies?

A: For over 30 years, Sumitomo's SHI Company had been a licensee of Foster Wheeler's CFB boiler technology, supplying 67 CFBs in the small to medium-size range, mostly to their home market in Japan. Whereas, Amec Foster Wheeler's CFB business was truly global, delivering the full range of CFBs from small industrial, CHP and WTE units to very large ultra-supercritical CFBs for utility power plants.

Sumitomo saw the acquisition as an opportunity to go global and greatly expand the size of their CFB boiler market and business. In addition to the CFB boiler technology, the acquisition included AmecFW's BFB boilers, fluid bed gasifiers, CFB scrubbers, fabric filters, specialized metallurgical waste heat boilers and a broad spectrum of aftermarket services. Like the CFB boilers, these additional products and services had unique market positions driven mainly by their fuel, application and operational flexibility.

Q: What is the market potential for SFW's CFB boiler technology?

A: Today, about 80-85 per cent of the global boiler market continues to stay with conventional pulverized coal (PC) technology. PC technology hasn't changed much over the last 50 years and still carries three fundamental disadvantages: very limited fuel flexibility, high air emissions and expensive emission control.

Over the last 40 years, SFW's CFB boilers have redefined the meaning of fuel flexibility, reliability and clean combustion without back-end controls. This has been noticed by utilities, IPPs, developers and industrial companies who have been selecting CFB boilers more and more.

So the CFB has lots of room to grow into the global boiler market because of the higher values it offers over PC technology. Even if the boiler market remains flat or even declines, CFB still has an upside growth potential of 80-85 per cent.

Q: Why hasn't CFB technology already taken more of the overall boiler market share?

A: Most of the global boiler market is in the large coal utility sector. Like most other energy markets, this capital-intensive sector is slow to accept change mainly because people tend to stay with what they know and have experience with.

The CFB market is still predominantly in the small to medium size range serving multiple sectors like industrial, WTE, CHP, district heating and cooling. This is where the CFB was born and is the market segment we still serve the most, because our CFBs are best able to reliably fire a diverse and wide range of challenging fuels demanded by these sectors.

But change is happening. Our first large 460 MW supercritical CFB went online at the Lagisza plant in Poland eight years ago. At that time, this was the world's first supercritical and largest CFB unit in the world. Last year, we commissioned 2000 MW of our ultra-supercritical CFBs at the Green Power Plant in Samcheok, South Korea. As of today, we have delivered 38 CFBs, each over 200 MW in capacity, totaling over 11 GW of electric capacity.

Q: What benefits does CFB boiler technology bring to the market?

A: Our CFBs offer value in multiple dimensions. Their fuel flexibility provides power generators and industrial plants with the ability to shop for the lowest cost coals, petcokes and lignites keeping power prices at the lowest levels. They can co-fire carbon neutral fuels up to high levels and employ highly efficient ultra-supercritical steam technology providing a flexible carbon reduction solution without turning to expensive carbon capture and sequestration (CCS) technology. Our CFB's can convert the environmental liability of industrial byproducts and waste into valuable power, steam and heat. Their clean burning process produces the lowest emission without needing expensive air pollution control equipment saving millions in plant construction and operating cost. And finally, they provide these benefits as a highly reliable and dependable base load capacity option to maintain grid stability.

Q: How do you see the CFB technology fitting into the global trend of carbon reduction?

A: Our CFB's can achieve a closed loop on carbon emissions by fully firing carbon neutral biomasses in both small and large plants. This provides a near net zero carbon solution without going to the expensive and uncertain carbon capture and sequestration (CCS) solution. Further, biomass is a renewable energy source. But unlike wind and solar, biomass plants can provide dependable energy on-demand which is a big advantage for a renewable energy source.

Looking beyond new build thermal plants, our fluid bed gasifiers can be retrofitted to existing PC coal plants to allow them co-fire the highest levels of carbon neutral fuels and waste, significantly reducing their carbon profile. Crossing over to the transportation sector, these gasifiers can also be integrated into biomass-to-liquid solutions to produce renewable biofuels and green chemicals.

But the 100 per cent biomass solutions are not a good fit for all markets since the logistics and cost of sourcing large and continuous supplies of biomasses and wastes can be very challenging. This is where our CFBs provides the flexibility to co-fire carbon neutral fuels with more dependable fuels like coals, lignites and petcokes that have well establish large scale supply chains.

In essence, the CFB allows each project to set the balance point between carbon emissions, fuel security and cost of energy. Since biomass supplies also vary seasonally, the fossil fuels can fill in as needed, providing energy security to consumers and financial security to project investors.

Q: And how do you see the CFB technology fitting into the global trend of renewables?

A: Globally we see nearly all markets strongly embracing solar and wind, which offer a true zero carbon solution, and with dropping prices, renewables are growing faster than ever before. But like biomass, too much wind and solar may not be a good thing.

We are seeing a growing trend of rising energy costs and declining power reliability in markets that have high penetration levels of over 30 per cent of wind and solar energy, like in Spain, Germany, and Australia. Without large scale energy storage, grid operators scramble to meet load when the winds dies down or clouds cover the sky. They are relying more and more on expensive fast-moving peaker-plants fueled by natural gas and oil to manage the growing intermittent capacity. The unwanted result of this is a direct relationship of increasing energy prices with increasing wind and solar capacity.

We at SFW have always believed in keeping all technology and fuel options in the generation mix for a balanced energy portfolio. As with any investment, a balanced portfolio provides the best protection against uncertainty of the future. As we all know too well, the energy sector has significant uncertainty related to changing policy, regulation, fuel availability and technology.

This is another area where the CFB provides value, since the same unit can burn the widest range of fuels, it provides the ability to rebalance the fuel mix without having to build another plant. And, it provides these benefits as a highly reliable and dependable base load capacity option to maintain grid stability.

Q: Where do you see the CFB option providing the most value in today's markets?

A: CFB can bring high value to countries that have large reserves of low quality lignites, coals and waste coals from mining operations, like: Colombia, Germany, Turkey, Russia, South Africa, Vietnam, Thailand, Indonesia, India, China and Australia. Using conventional PC technology, these low-quality fuels drive boiler size, cost, and maintenance and plant downtime way up.

After a long difficult experience with these fuels, many countries simply turn to importing high quality coals or LNG. Today, CFB technology has been proven at the large scale to economically, cleanly and reliability convert these low rank fuels into power and steam, lowering the countries energy cost and improving their energy security. The CFB technology also keeps the door open for co-firing coals, petcokes and biomass from either import or domestic sources, when prices or regulations is right, so you don't have to lock yourself into one fuel source.

In broader Asia, over the last 10 years, high moisture sub-bituminous Indonesia coal exports have exploded, driven by deep price discounts in the 15-40 per cent range. The same CFB boiler can fire the full range of these fuels with heating values spanning the 5000-3900 kcal/kg range, as well as, high quality Australian coals in the 5500-6000 kcal/kg range, capturing the full arbitrage of this fuel market. PC plant operates are forced to trade reduced plant performance, higher downtime and maintenance cost to capture a much smaller range of these fuels. Staying with PC

technology, their only other option is to build another PC plant designed for another narrow fuel range.
India has very low quality domestic coals, which represents their most affordable energy source. Plant operators have struggled for years to burn these coals with conventional PC technology and like Turkey has turned to importing higher quality, more expensive coals. Concerned about fuel security and raising energy costs, India's government has begun prioritizing the use of domestic coal over imported coal for future power projects. Some projects are forced to burn a mix of Indonesian and domestic coals, which is a struggle for PC boilers. CFB technology dovetails perfectly with the country's energy goals and objectives, including India's ultimate goal for being energy independent.
Japan is another good example where CFB technology can make a difference. The energy situation in Japan is critical right now, given that the country has shut down all but two or three nuclear units.
The huge power gap is being filled with expensive LNG and liquid oil. Coal is a very economically attractive base load alternative for Japan. Historically, Japan has been firing the most premium grade 6,000 kcal Australian coals in its fleet of ultra-supercritical PC boilers to achieve the highest plant efficiency to minimize operating cost.
Here, the CFB option can provide high plant efficiency with its ultra-supercritical designs, but more importantly, can tap into the much higher cost savings of utilizing lower cost, lower quality Indonesian coals. Further, we are seeing a declining supply of premium coals globally limiting supplier competition and Japan negotiating position. Large utility scale CFBs would break Japan out of this procurement box.
Q: What trends have you been seeing in the biomass energy markets?
A: Over the last 10 years, we have witnessed a competition for clean wood between the energy, construction, and furniture industries. After successful lobbying by the construction and furniture industries, governments have shifted their biomass energy program away from clean woods toward lower quality, recycled and demolition woods, as well as, agricultural waste streams and byproducts like palm kernel shells and bagasse.
These fuels are much more difficult to burn due their higher level of corrosive alkalis, chlorine and non-combustible debris. Responding to this change in policy, we developed robust CFBs designs to help our clients utilize these more challenging fuels.
The impact of this change in policy can best be seen at the low end of the size scale (50-100 MW), where we are seeing a growing market for multi-fuel CHP plants.
As an example, we are currently suppling a CFB to a 75 MW CHP plant that will provide power and heat to the town of Zabrze in Poland. The plant will be fueled by locally sourced municipal waste, biomass and coal.
It is a sustainable, closed-loop energy solution providing energy security, waste recycling and low carbon emissions at the community level.
In Korea and Japan, we are seeing a number of similar multi-fuel power and CHP plants using a combination of local waste and recycled woods, as well as, imported

biomass pellets and agricultural byproducts. In Dangjin, Korea, we recently provided a CFB to a 105 MW power plant in Dangjin, Korea that fires wood pellets, recycle furniture chips and imported palm kernel shells. This plant originally fired coal as well, until the government changed its fuel import policy.
At the large end of the scale (150-300 MW), we are seeing some governments supporting large scale utility power projects fueled by dedicated biomass and agricultural sources. In Polaniec, Poland, we recently built a 200 MW power plant that fires biomass and agricultural byproducts and in Teesside, UK we are building a 299 MW plant that will fire imported wood pellets from the US.
(https://www.powerengineeringint.com/articles/print/volume-26/issue-3/features/cfb-technology-in-a-low-carbon-world.html)

CFB in Turkey: The right timing for the right technology

Turkey's GDP is predicted to grow nearly 60 per cent over the next five years, ranking as one of the fastest growing economies in the world. This high level of economic growth, coupled with Turkey's strongly growing industrial base, is expected to drive electricity demand growth from 95 TWh to 132 TWh, nearly a 40 per cent increase over the same five-year period. To keep up with this insatiable need for power, Turkey's energy imports are expected to grow considerably, causing both an energy security and economic burden concern.
In 2016, 33 per cent of Turkey's electric power was produced from imported natural gas, half of that from Russia and more than half of its coal and lignite power was from imported hard coal. Only 16 per cent of Turkey's total electric power was generated using local lignite
When commissioned in late 2018, the 2 x 255 MW Soma Kolin Power Plant will become the largest CFB plant in Turkey. Source: Sumitomo SHI FW
The situation is even worse when looking at the total primary energy demand of the country, as only 30 per cent is sourced from domestic sources such as hydro, lignite, and renewables. Said another way, 70 per cent of Turkey's economy is fueled by imported energy, costing Turkey $27.2 billion in 2016.
Turkey has 17.2 billion tonnes of proven lignite reserves, enough to power its growing economy well into the future. But ironically, over the past five years, imported coal capacity grew 3.5 times more than lignite power capacity (4.9 GW vs 1.4 GW). Policymakers in Turkey want to change this to improve Turkey's energy security while lowering its energy cost.
Tapping into Turkey's massive lignite reserves is a key part of Turkey's Vision 2023 energy plan, timed to mark the 100th anniversary of the founding of the Republic. The plan calls for increased use of lignite for meeting rising electricity demand while improving Turkey's energy security. The plan calls for more than doubling domestic lignite power capacity over the next 10 years, amounting to 10 GW of new power capacity from Turkey's lignite.
The good news is that Turkey's huge lignite reserves can solve its energy security problem. The bad news is that 68 per cent of the total lignite reserves in Turkey have

low calorific value (1.000–2.000 kcal/kg) which is a very challenging fuel for today's conventional coal power plant technology.
It is no coincidence that Turkey has not turned to its lignite reserves earlier, and you don't need to look very hard to find power plants that struggle every day to burn its low quality lignite.

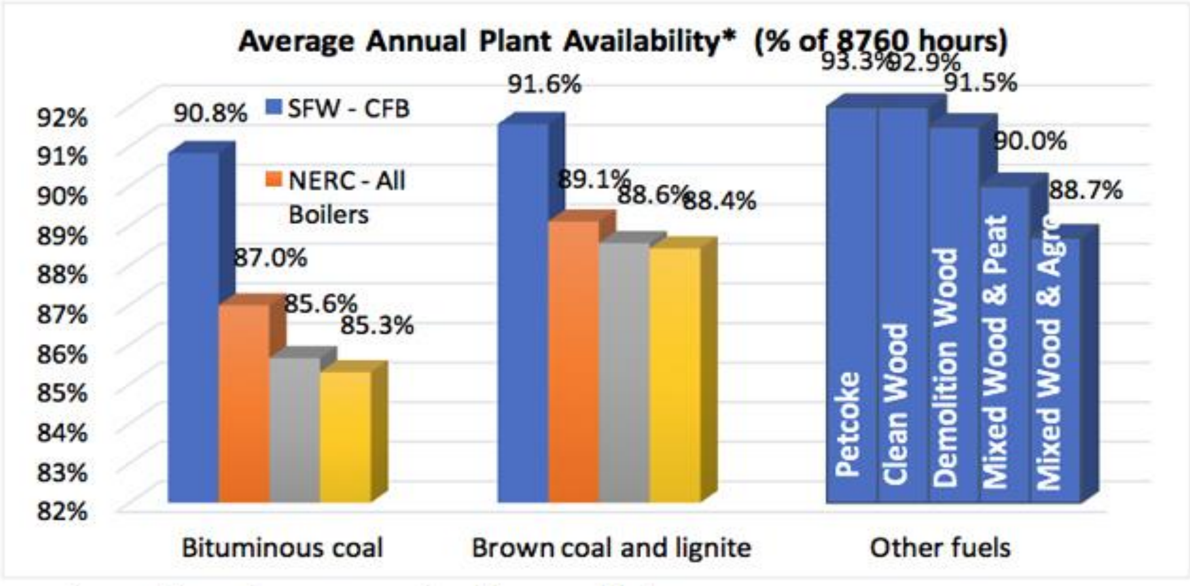


Figure 1. Annual average plant availability of SFW CFBs and coal plant fleets

Right time for the right technology
Today, the timing couldn't be better for aligning the right technology to Turkey's energy strategy. Over the last 40 years, circulating fluidized bed (CFB) combustion technology has grown in both scale and experience. Today, CFB has become the best choice for reliably and cleanly converting low quality fuels into power.
In a broader sense, CFB's fuel flexibility and ability to control pollution during the burning process has caused many utilities, IPPs and developers to choose CFB technologies for their new coal, lignite, biomass, petcoke, and waste-to-energy plants.
But for Turkish lignite, the key words are ash and moisture, since Turkey's low quality lignite has the highest levels of them, in the 30–50 per cent range. Moreover, the ash has very low melting temperatures making quite a slagging mess in conventional boilers.
In a conventional pulverized coal (PC) or PF boiler, this ash melts causing slagging and fouling throughout the boiler. These boilers are oversized, use a lot of soot blowing, and are frequently down for maintenance, resulting in elevated plant capital and operating cost and lower plant reliability.
The CFB technology avoids all these pitfalls, since the ash doesn't melt due to its flameless low temperature combustion process. Instead, the ash is circulated throughout the boiler, cleaning the boiler's heat transfer surfaces and evenly spreading the fuel's heat while completely combusting the fuel.

This one difference is the main reason that CFB boilers can achieve reliability levels unreachable by conventional PC boilers. Figure 1 shows average annual plant reliabilities between plants with SFW CFBs as compared to coal plant fleets in several world regions reported by multiple sources.

There are many other advantages of the CFB combustion process. For instance, the CFB does not need fuel dryers, pulverizers, conduits, or burners. Instead, the fuel needs to be only coarsely crushed and dropped into chutes in the lower furnace. Most of the time, expensive SCR DeNOx or downstream FGD DeSOx systems are not needed to meet permitted emission limits.

Combustion stability and efficiency is another area where CFB excels. Since the CFB circulates the fuel over and over in a bed of hot solids, it completely burns all fuels, even the most difficult low volatile fuels, like anthracites and petcokes. Fuel particles can stay in the CFB hot loop for as long as 30 minutes as compared to a PC with burning times of only three-to-four seconds.

Further, the bed of hot solids in the CFB provides a large thermal inertia. This makes the combustion process very stable, allowing wide variations in fuel properties without upsetting boiler emissions or steam capacity. In contrast, the PC burning process has no thermal inertia since the fuel is instantly converted to a hot gas and molten ash particles.

The Soma Kolin project

The new Soma power plant is located in Soma Basin, 135 km north of Izmir. The owner, Hidro-GEN Enerji Ithalat Ihracat Dagitim ve Ticaret, is a subsidiary of Turkish construction company Kolin Holding.

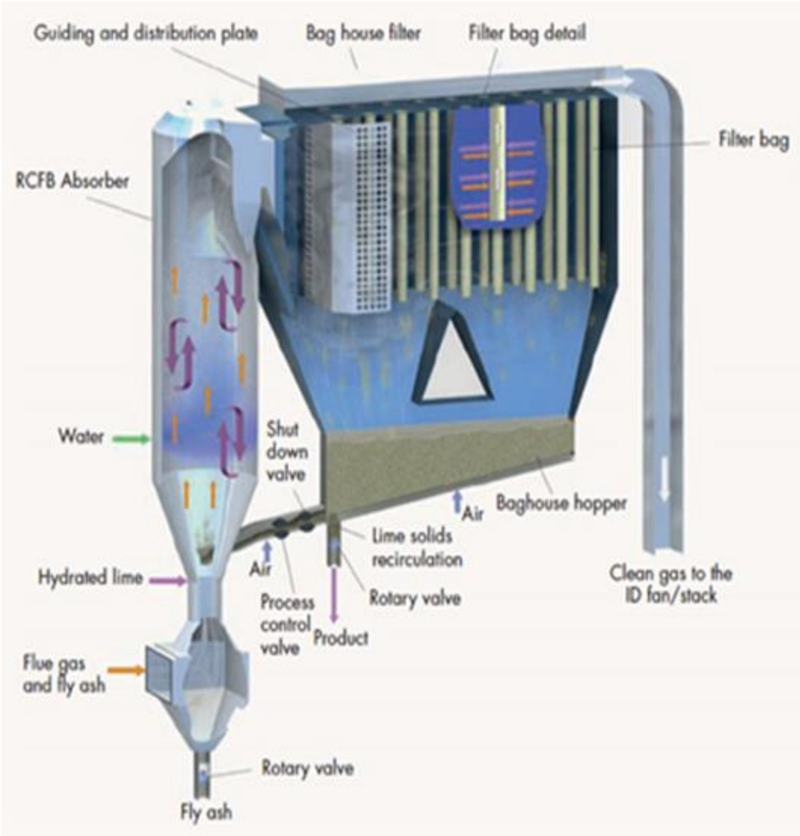
Hidro-GEN is following through with its plan to open the new lignite mine and build the 510 MW lignite CFB power plant designed around SFW's CFB boiler technology. When operational in 2018, the plant will become Turkey's largest lignite power plant utilizing CFB boiler technology. The plant is configured with 2 x 255 MW CFB boilers and steam turbine generators.

The contract for the supply of two CFB boiler islands with auxiliary equipment and the two CFB scrubber systems was awarded to SFW in January 2014 by EPC contractor Harbin Electric International. A number of local Turkish subcontractors are working on the plant site in different areas of the power plant and mine.

After a short project delay related to final site selection approvals, construction began on the plant in January 2016. Boiler hydro is scheduled for late 2017 and plant commercial operation is scheduled for mid-2018.

Building a lignite-burning power plant in the Soma region makes good economic and fuel security sense, but the challenge was finding the right technology to fire this very low quality lignite with a higher heating value of 6770 kJ/kg (1618 kcal/kg), containing 23.3 per cent moisture, 42.9 per cent ash and 1.2 per cent sulphur.

Each CFB is a natural circulation steam generator with reheat rated at 255 MWe (545 MWth). Main steam conditions of the CFBs are 173 bar abs/565oC with reheat conditions of 53 bar abs/565oC. The CFB boiler design includes steam-cooled solid separators and special INTREX heat exchangers, which are utilized as the final superheating stage. Due to the high ash content in the fuel, the CFBs are equipped with high capacity drum coolers which drop the bottom ash into redundant drag chain conveyors.



Emission flexibility

Since Turkey's government has been considering accession to the European Union, flexibility in plant emissions was important to the Kolin Group, the owner or the plant. They wanted to have the flexibility to achieve a wide range of stack emissions, while at the same time allowing a wide range of fuel sulphur contents expected from the lignite mine over the long term.

Currently, Turkish environmental regulation is based on Europe's large combustion plant directive (LCP) with SOx/NOx/PM emission limits of 200/200/30 mg/Nm^3.

But current EU environmental rules are based on the Industrial Emissions Directive levels which recently have been updated by the BREF BAT document. The BREF lowers yearly SOx limits down to the 10–75 mg/Nm^3 range, NOx down to the 50–85 mg/Nm^3 range and PM down to the 2–5 mg/Nm^3 range for large new coal and lignite plants. In addition, the BREF adds strict limits in the 1–3 mg/Nm^3 range to several new pollutants, such as, HCl, HF, Hg, and NH3.

For this flexibility, a CFB 'polishing' scrubber (CFBS) was added behind the CFB boiler for the Soma Kolin plant. This will allow the CFB ash to be used as a reagent in the CFBS to reduce emissions while also reducing the use of expensive reagents such as hydrated lime.

Two ash hydrators on-site will condition the recycled fly ash before injection into the absorber. The CFBS will also capture HCl, HF, Hg, and NH3 so the plant will be able

to comply with the EU's strict BREF limits providing multi-pollutant emission control very economically.
The Soma Kolin project is very important to Turkey as well as other countries with large resources of low quality coals and lignites. CFB technology is the best choice for tapping into Turkey's vast lignite reserves, as underscored by the project.
The success of Soma Kolin will encourage countries, such as India, Germany, Thailand and Pakistan to reconsider their plans for using their low quality indigenous fuels for secure, affordable and clean power.
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(https://www.powerengineeringint.com/articles/print/volume-25/issue-11/features/cfb-in-turkey-the-right-timing-for-the-right-technology.html)

Why fuel flexible CFBs are the future

Only circulating fluidized bed combustion technology satisfies all of the often contradictory design requirements of modern solid fuel plants, writes Robert Giglio
New wind and solar projects continue to dominate recent global capacity increases.
But when dispatchable power is required, particularly in developing countries, coal remains the fuel of choice for utility-scale plants. Global coal use for power generation continues to rise primarily due to rapid growth of the Indian, African, and Asian power markets that value low cost solid fuels.
Every steam plant built today has unique design fuel requirements. For example, economic and policy constraints often dictate use of difficult to burn indigenous fuels or co-firing with biomass or agro fuels.
Also, in most power markets, flexible yet reliable plant operations – such as rapid dispatch rates and spinning reserve – are essential because renewable assets, particularly rapidly fluctuating solar and wind generators, are positioned higher in the dispatch order.
Finally, plant owners desire the least expensive fuel available, often sourced globally, to avoid being tethered to a single fuel for the life of the plant. Only circulating fluidized bed (CFB) combustion technology satisfies all of these often-contradictory design requirements.

Fuel markets in flux

The traditional 6000 kcal/kg global steam coal market has flourished for the past 50 years but lately the market has experienced a rapid transition where price often trumps quality.
As coal mines mature, mining operations move to lower quality coal seams. Indonesian coal, for example, dominates the global coal market with about 50 per cent of its exports being high-moisture, sub-bituminous coals with gross-as-received higher heating value (HHV) ranging between 3,900-4,200 kcal/kg.
Furthermore, the best-quality Indonesian coal reserves are expected to produce coals with average HHV no greater than 5200 kcal/kg (with economical washing levels) in

the future. The resulting trend is a growing supply of discounted coals, domestic lignites, and waste coals that provide a significant economic advantage for fuel-flexible plants capable of burning these lower rank, less expensive fuels.
The shift toward a more flexible solid fuel market, where buyers and sellers are pleased to trade fuel quality for price, appears to be permanent.
Expanding low quality solid fuel markets have dramatically increased the value of fuel flexibility for utility-scale power plants and have been the primary driver behind the large CFB power plants coming on-line over the last 10 years, examples of which are included at the end of this article.
CFB plants, unlike pulverized coal (PC) plant designs, give plant owners a choice whether to stay with premium steam coal or to venture into the broader fuels market and leverage the available price discounts for lower rank coals, even for ultra-supercritical plant designs.

Fuel combustion flexibility

Changes in the global solid fuel market provide a market advantage to owners of plants that are fuel agnostic. But fuel flexibility means more than just being able to burn a wide range of coals or even coal and biomass mixes. It also means that plant reliability, maintenance, ease of operation, and stack emissions must be largely unaffected over a very wide range of fuel quality including coal and biomass fuel mixes.
PC boilers have trouble burning low quality fuels due to its narrow fuel specification that typically demands 5500 kcal/kg (23 MJ/kg) HHV or higher energy content, fuel moisture below 30-35 per cent, and volatility above 20 per cent.
Lagisza CFB Power plant is the longest-operating supercritical CFB power plant in the world
Lagisza CFB Power plant is the longest-operating supercritical CFB power plant in the world
However, this is not the case for CFB technology. Modern CFBs can efficiently burn both low rank coals and lignites with heating values ranging from 1000 to 8500 kcal/kg (4 to 35 MJ/kg), fuel ash and moisture levels as high as 60 per cent and volatiles down to 5 per cent.
The CFB's high reliability when burning low rank coals is based on its unique flameless, low-temperature combustion process. Unlike conventional PC boilers that rely on an open flame, the CFB's circulating solids are used to achieve high combustion and heat transfer efficiency. Fuel circulates until completely burned. The ash in the fuel does not melt or soften at low bed temperatures which allows the CFB to avoid the fouling and corrosion problems encountered in conventional boilers.
From an environmental aspect, the low temperature CFB combustion process minimizes NOx formation and allows limestone to be fed directly into the furnace to capture SOx as the fuel burns. In most cases, SCR and flue gas desulphurization (FGD) systems are not needed for NOx and SOx control, dramatically reducing the plant's first cost, annual O&M cost, and water consumption while improving overall plant reliability and efficiency.

For a PC boiler to control fouling, slagging, and corrosion when burning low rank coals, such as high sodium lignite, the furnace cross section and height must increase considerably, as much as 45 per cent in height and 60 per cent in footprint.

Also, unlike a PC, a CFB doesn't need soot blowers to control the build-up of deposits and slag in the furnace since the circulating solids keep the furnace walls, panels and steam coils clean, allowing for the most efficient heat transfer possible while reducing boiler maintenance.

Thermographs of CFB and PC furnaces illustrate the thermodynamic differences between the two combustion technologies (Figure 1). The green regions are where the combustion temperature is around 850C while the red regions show temperatures nearly at 2000C.

The key design criteria for the CFB is that the combustion temperature (everywhere) is well below the fuel's ash melting temperature. Since the ash doesn't melt, fouling and corrosion is minimized throughout the entire boiler (furnace and convection pass) allowing the CFB to achieve reliabilities unreachable by PC boilers.

The lower combustion temperatures minimize the amount of NOx formed, often allowing the plant to avoid the expense of an SCR. In addition, limestone can be added directly into the furnace to capture acid gases like SO2, SO3, HCl, and HF preventing these corrosive elements from causing corrosion and fouling for throughout boiler, air heater and particulate matter control equipment. In most projects, adding limestone to the CFB can achieve the required SO2 stack emission without the need for a downstream FGD.

Finally, unlike PC boilers, the fuel doesn't have to be finely ground, dried or dispersed into the furnace by burners avoiding the cost and maintenance of fuel dryers, mills, coal pipes and burners. For the CFB, the fuel is coarsely ground and dropped into fuel chutes using gravity to get the fuel into the boiler.

Superior life-cycle economics

It's a well-known industry fact that steam generator outages are the single largest contributor to reduced plant availability, which therefore determines the project's financial success (Figure 2). For example, consider a 600 MW supercritical coal plant that burns $50/tonne (4500 kcal/kg) Indonesian coal and sells power at $100/MWh at a base 90 per cent capacity factor.

A loss of four percentage points in annual capacity factor will reduce the plant's bottom line economics $13.8 million for the first year, or $212 million over its 30-year operating life. The CFB demonstrates up to an average 5.5 percentage point superiority in plant availability factor over 15 years, depending on fuel selection.

The cost of fuel is the largest line item on the balance sheet for any power plant so the economic advantage often goes to the plant that can operate reliably with lower rank, and therefore lower cost, fuels.

The magnitude of the fuel cost savings can be demonstrated by using the same supercritical plant example above firing $70/tonne (5,500 kcal/kg) coal as a base. Reducing the cost of fuel by $10/tonne will add $7 million to the plant's bottom line for a single year and $102 million over 30 years.

Plant case studies

There are many recent projects that illustrate the successful application of Sumitomo SHI FW CFB technology in circumstances much like the above case study. The following four projects illustrate the fuel flexibility of the CFB, each in unique applications.

The Lagisza CFB Power plant is the longest operating supercritical CFB power plant in the world today. Located at Tauron's Lagisza power plant in Bedzin, Poland, the plant has been in operation since 2009.

At the heart of the plant is a 460 MW supercritical SFW CFB featuring many unique first-of-a-kind design features and a very impressive net plant efficiency of 43.3 per cent (LHV) on bituminous coal.

Perhaps most importantly, the plant meets its permitted stack emissions without SCR or FGD equipment, thereby saving Tauron over $100 million in its construction cost and millions more each year in avoided O&M costs.

CLECO's Brame Energy Center, located in Boyce, Louisiana, in the US, is noted for its ability to burn a wide-range of market fuels. The plant consists of twin CFB boilers feeding a single steam turbine generator the produces 660 MWe.

The plant is designed to burn multiple fuels, including 100 per cent petroleum coke, 100 per cent Illinois No. 6, 100 per cent sub-bituminous Powder River Basin coal, and can co-fire up to 92 per cent lignite or co-fire up to 5 per cent paper sludge or wood waste. The plant entered commercial service in February 2010.

The DGF Suez Energia Polska Polaniec Plant, located in Polaniec, Poland, is the world's largest biomass CFB power plant. The 205 MWe (gross) plant burns a spectrum of wood biomass and agricultural crops and byproducts. The net plant efficiency is 36.5% (LHV).

Perhaps the most impressive example of a utility-scale CFB plant is the 2200 MW Samcheok Green Power Plant currently being commissioned in Samcheok, South Korea.

The Samcheok plant has four 550 MW Sumitomo SHI FW CFBs utilizing ultra-supercritical steam conditions (257 barg, 603C/603C). The plant will meet even tighter stack emissions without using FGD equipment, saving Korea's Southern Power Company (KOSPO) over $250 million in construction costs.

The plant is designed to burn a wide range of import coals, including sub-bituminous high-moisture coals (20-42 per cent). The CFBs are also capable of co-firing indigenous bituminous coal and up to 5 per cent biomass. The plant is designed to operate with a 42.4 per cent net efficiency (LHV) and went into full commercial operation in December 2016, taking their place as the most advanced CFB units in the world.

(https://www.powerengineeringint.com/articles/print/volume-25/issue-9/features/why-fuel-flexible-cfbs-are-the-future.html)

Mapping coal plant emissions

Mapping software can be used to bridge the gap between the science needed to understand air pollution and the engineering required to mitigate it, writes Arne Berndt

Since we began extracting and burning coal on a large scale back in the 17th century, it has proved to be both a blessing and a curse – providing cheap energy for millions on one hand, but blighting our environment on the other.

Tackling the emissions produced through coal production is a challenge we need to rise to – until viable energy alternatives are implemented on a wide scale – to protect our health, our planet and our businesses,

The World Health Organization estimates that ambient (outdoor) air pollution in both cities and rural areas caused three million premature deaths worldwide in 2012 (the latest figures available), and despite some efforts, things won't have improved since. For instance, London breached its annual air pollution limits just five days into 2017.

Alongside the fatalities, many millions more people are affected by respiratory diseases caused by air pollution. There is also a strong correlation between exposure to air pollution and cardiovascular diseases. At the other end of the scale, air pollution can cause temporary ailments like headaches and skin rashes.

That's enough problems without even delving into the climate change debate.

Coal, of course, is not the only source of air pollution, but it is considered to be the most significant by some degree. Burning coal is the biggest single source of carbon dioxide emissions from human activity according to international environmental organization Greenpeace. It reports many harmful pollutants in the air from coal, which pose a serious threat to our health and environment, including issues such as smog and acid rain. The continuous nature of energy production in coal plants just adds to the problem.

A changing approach

Across the world, alternatives to coal power are being explored and developed. Along with solar and wind power initiatives, there are various trials of new batteries that can store renewable energy and increase reliability.

In China, where air pollution has become a significant public health issue in some areas, not least Beijing, they will begin turning coal plants into nuclear reactors next year, but we are a long way from reducing our reliance on coal, which is used for 44 per cent of electricity generation in the US, for example.

As coal plants are to continue, emissions need to be reduced, so it is important to fully understand where they come from and where they go following release. The source of the outputs of the plant may be largely obvious, but the dispersion after that is also important if it is to be effectively mitigated.

'Dispersal' refers to what happens to the pollution during and after its introduction into the atmosphere, factoring in wind conditions and atmospheric changes. Understanding this can help people identify and control it. The pollution may be visible as it leaves the plant, but it soon becomes an invisible problem, except where it forms as smog.

Bridging the gap

While mapping technology can't directly reduce emissions, the ability to accurately map their sources and distribution can be invaluable, as can virtual testing of mitigation options before committing time and expense to solutions.

Mapping software can be used to bridge the gap between the science needed to understand air pollution and the engineering required to mitigate it. Air pollution dispersal is a central focus for environmental conservationists and governmental environmental protection agencies (local, state, provincial and national) in many countries as a means of air pollution control.

Accurate wide-scale measurements of air pollution are difficult to get as, even when assessed at several monitoring stations in different locations, the terrain and weather factors mean that levels can vary greatly even in small areas. Therefore, instead of relying on potentially inaccurate measurements, mapping software allows a number of models to be used to map air pollution dispersal. These range from base models to 'simple' Gauss models – for approximate calculations, e.g., to estimate background concentrations or to make worst case studies, whenever free flow conditions can be assumed around emission sources – up to complex prognostic models. The model selection depends strongly on the task and the available data.

Air pollution models are highly dependent on the meteorological situation for the dispersal calculation, requiring multiple meteorological scenarios. In order to correctly assess the pollution load for average and various percentiles, the principal concern is simulating the dispersal of the pollutants for a wide variety of wind directions and scenarios. An added variant is that the air pollutants are often reactive gases which change over time under the presence of UV light.

Critical tools

As well as looking to improve the environmental situation, the results of air pollution models are often critical in planning processes and need to be robust enough to withstand the scrutiny of the court system. It is essential that they can be validated and have well-defined boundary conditions, are supported by a team of experts and are used by well-trained people.

The management of meteorological conditions and the control of different scenarios are a constant focus for developers and software improvements regularly mean what was impossible yesterday might be possible today. Measured meteorological data must be extremely well assessed and modified very cautiously, especially if the reference meteorological station is outside the investigation area. Developers continually add tools to assess, complete and modify data.

Consequently, air pollution mapping software has become a powerful tool to save time and avoid nasty surprises when inspecting calculation results. Some software includes diagrams to analyze background pollution measurement and to deliver supporting arguments to why the background concentrations need to be adjusted.

If poor measurements cannot be rectified, this software helps visualize data problems and supplies good arguments for better data.

Once air pollution has been accurately mapped, then the software can be used to test different mitigation options, which may include carbon capture initiatives. Using the software to test in this virtual way means that all options can be tested without incurring costs and the best methods can be selected.

Noisy neighbour

Air pollution isn't the only emission to be concerned about in coal plants. Like the vast majority of industrial premises, they are also noisy. Noise emissions are considered harmful if people are exposed to levels of 85 decibels (dB) or above for a continuous period; a sudden louder noise can also be detrimental.

Whether the impact is temporary or permanent hearing loss or other physiological or psychological effects, it can have serious repercussions for the victim(s).

Mapping software can once again help. Noise can be displayed in coloured maps, making it easy to understand the sources and propagation. They can also be produced in 3D and animated form so that the problem is truly understood. The most advanced software is sophisticated enough to map a single room or an entire country.

Using the maps in coal plants, mitigation measures, such as replacing turbine equipment with quieter models, for example, can be tested and the noise contour line established. The line is the point at which noise levels reach 85 dB and anyone crossing it should be wearing personal protective equipment, such as ear defenders.

Noise sources in coal plants vary widely in sound power, emitted frequency spectra and directivity, and also in their time dependency. Using mapping software is more effective than taking measurements as the software can break down the sources and doesn't just work with the overall sound.

Controlling air pollution and noise emissions from coal plants is not just about being good for the environment, as important as that is. Without taking action, the health and safety of employees, visitors and local residents is threatened. As well as the personal impact, this can mean costly downtime and potentially expensive litigation. Mapping the issues and demonstrating the mitigation measures taken can help reduce those risks.

(https://www.powerengineeringint.com/articles/print/volume-25/issue-7/features/mapping-coal-plant-emissions.html)

How to cut mercury emissions in coal-fired power plants

Both the development of mercury control technology and its installation in power plants follow the evolution of emissions regulations. With a new standard in the works for Europe, Tildy Bayar investigates what it will mean for mercury control technology companies and Europe's power plant operators.

New EU rules on mercury control are expected

In a March note, Greenpeace EnergyDesk editor Christine Ottery wrote that European environmental regulations for power plants, which are expected to be finalized by 2016 and come into force by 2020 as part of the Industrial Emissions Directive (IED), "could change the face of Europe's energy system ... though hardly anyone knows they exist."

Analysts have speculated that the regulations, known as the large combustion plant best available techniques reference document (LCP BREF), could force large numbers of coal-fired power plants across the EU into retirement by 2025.
Along with establishing stricter limits for SOx, NOx and particulate emissions, the regulations, known as the large combustion plant best available technology reference document (LCP BREF), will likely set standards for mercury emissions from power plants. Unlike the US, Europe currently has no set standard for these emissions, and thus the major market for mercury control technologies to date has been North American. In Europe, the need for legislation specifically dealing with mercury has largely been addressed by the mercury reduction co-benefits available from technologies used to comply with existing legislation (the Large Combustion Plant Directive and the current version of the IED) on SOx and NOx removal.
The mercury emissions limits being considered in the draft BREF for plants over 300 MW range between 0.2 μ/m3 and 10 μ/m3. Dr Lesley Sloss of the International Energy Agency's Clean Coal Centre said in May that while "the actual value has yet to be agreed and the applicability of the proposed limits has yet to be defined," the new BREF "could mean ... there may be a new mercury control market opening up in Europe within the next few years."
And this market could expand even further. Mandar Gadgil, Air Quality Control Systems Engineer with Babcock & Wilcox (B&W), notes that "in the next four to five years, Germany will enact the BREF regulation, and Europe may follow. China, India, South Africa, and other coal-burning countries will implement new regulations. It may take five years or so, but by 2025 I think all plants will have to control mercury all over the world."
However, Jorgen Grubbstrom, Product Marketing Manager for Dry FGD Environmental Control Solutions with Alstom's* Steam Business, says the European market may be slower to develop than expected. "Suppliers, member states and different stakeholders understand that it's very important to have the correct conclusions as they may drive a lot of changes for the power industry," he says. "[The BREF] is taking more time than expected - it's a tedious process - so they are in delay."
Bernd Volmer, Process Engineering & Design AQCS at Mitsubishi Hitachi Power Systems Europe (MHPSE), says his firm will be ready when the time comes. "The US, compared to Europe in regard to mercury reduction, is in front of us," he says, "so we learn from our partners in the US about the technologies and will implement these also on the European market - the emission values will come into force in 2016-17, and plants will be required to comply in 2020-21."
Standards development, Volmer notes, is "an ongoing, rotating process". While power plant operators will be given four years to implement the expected BREF standard, he explains, a subsequent revision will be issued in eight years. "So there is a time interval between a revision of eight years and compliance duration of four years. Every four years a utility will comply with the regulation, then it has another four years' time to implement a new revision of the standard reflecting the updated technology.

"We have to continuously improve the technology in response to the continuous challenge of emission values," he says.

How it works

The basis of the control process is the oxidation of mercury, and then its removal within downstream equipment before it is emitted through the stack into the atmosphere. The most common technology involves injection of activated carbon into the plant's exhaust stream.

Mercury comes in three forms: metallic, ionic and particulate. "The goal is to oxidize all metallic mercury to ionic mercury so it can be removed in the flue gas desulphurization (FGD) system," explains MHPSE's Volmer.

According to B&W's Gadgil, "the main workhorse of the industry for mercury control in the US is powdered activated carbon (PAC) - both halogenated (usually bromine is the halogen of choice) or non-halogenated depending on how much mercury is in the gas phase." Another "very efficient" and widely used technology is halogen injection into the coal itself.

"It's very simple," Gadgil says. "Calcium bromide or sodium iodide is added to the coal. It's an inexpensive process and results in very high mercury oxidation. The only catch is that for halogen addition to work on its own as a mercury control technology, there has to be some sort of FGD system. Oxidized mercury is very soluble and can be taken out in the FGD."

There are other sorbents in use, Gadgil adds, such as amended silicate, which is "as good as activated carbon but has not been as widely used due to economic reasons."

Gadgil also confirms that "sometimes there is re-emission of mercury - this has happened in some plants. If there are 2μg of elemental mercury going inside a wet scrubber and 3μg coming out, that's re-emission," he explains. "This happens because of the chemical nature, processes and the atmosphere inside the scrubber, and as a result some of the oxidized mercury goes from the oxidation phase to the elemental phase. To address that, we have a sulphide-based additive, sodium hydrosulphide, which has proved very effective in controlling re-emission. Other companies have their own re-emission control additives."

Alstom's Grubbstrom notes that, "since re-emission is a function of the chemistry of the slurry, in particular the sulphite content is of importance to monitor and control this parameter." To this end, his firm has recently launched a sulphite analyzer which also measures oxidation reduction potential (ORP) and controls the flow rate of oxidization air to the wet FGD.

MHPSE's Volmer says the mercury reduction process involves looking at existing plant equipment and "how you can optimize it to meet requirements. For a system where you already have [mercury] mitigation through selective catalytic reduction (SCR), the use of SCR with special types of catalyst is a very low-cost mitigation process, together with a downstream wet FGD equipped for mercury removal."

Control technologies oxidize mercury for removal in the flue gas desulphurization (FGD) system

Alstom's Grubbstrom says his firm takes two main approaches. First, a system based on injecting an adsorbent such as PAC upstream of the air preheater in a high-temperature area and collecting it later in an area of at least 50 degrees lower to enhance adsorption. A milling system reduces the size of the PAC to increase the surface area of the sorbent and enhance mercury capture on the surface of the carbon particles, Grubbstrom says.
Secondly, an enhanced PAC process which includes a sorbent storage silo and an injection system comprised of a series of lances in the ductwork, designed to optimize contact between flue gas and PAC. The mercury, PAC and fly ash are removed in a fabric filter.
Gerhard Heinz, Director of Sales & Marketing for Alstom Thermal Services Central Europe & CIS, notes that higher temperatures favour the kinetics of oxidizing elemental mercury and increase the extent of chemical absorption. In addition, "injecting in a high-temperature area before the air heater increases absorption because the mercury is in contact with the flue gas for a longer time," he says. The mercury is then collected in the electrostatic precipitator (ESP), which "might need to be upgraded a bit to fulfil lower particle emission requirements," he notes.

Different strokes for different plants

Daniel Chang, Air Quality Control Service Area Leader with Black & Veatch Energy (B&V), notes that attention to site-specific constraints is needed to determine the best mercury compliance solution. "We take into consideration the performance of emissions control technology to reduce emissions to required limits, the ease of integrating into an existing power plant, and then the cost to implement the technology," he explains.
"For example," he says, "two different power plants located in different regions may be combusting different kinds of coal. This usually means a difference in the amount of mercury emitted, which could be in terms of quantity as well as composition. Secondly, coal-fired power plants can be configured very differently in terms of the way coal is combusted. The back end of the unit is also very different in terms of types of equipment installed for capturing emissions of SO2, particulate matter and NOx."
Power plants burning bituminous coal, which has a higher sulphur content, are prevalent in the eastern US, Chang notes. This type of plant is generally equipped with a NOx reduction system such as an SCR. Depending on the age of the unit, some will have ESPs or, if built later or retrofitted, a pulse jet fabric filter (PJFF) to reduce particulate emissions from the flue gas stream, followed by a FGD system. Wet FGD is the most typical, Chang says.
When injected into the flue gas, PAC captures mercury in the pores of the carbon particles, he explains. Collection usually takes place within the ESP or the PJFF as well as within the wet FGD system, where water sprays collect it in the by-product area.
"This is a commonly used approach to mercury reduction," says Chang. "However, there may be other approaches within this kind of configuration where PAC could be avoided or its consumption reduced" through co-benefit. "This happens when you

have an SCR which has a catalyst system that will help oxidize mercury, and then the oxidized mercury can be captured in the wet FGD system," he explains.

For the low-sulphur coal that comes from the western US, a typical power plant could be configured with a boiler, NOx reduction system, SCR, then a dry FGD system paired with a PJFF to collect particulate matter as well as by-product from the SO2 removal process. The primary mercury removal method for these plants is PAC. For these plants, Chang says, "due to the composition of the coal, the forms of mercury are usually less oxidized so you always need to consider a halogenated form of PAC where the halogens help promote a reaction that converts it to oxidized mercury to improve the capture rate." For a lignite-fired plant, he notes, the optimal mercury compliance solution would be equivalent to this US example.

B&W's Gadgil concurs that existing equipment installed at a plant can affect technology choices. "For example," he says, "if the only air quality control equipment a plant has is an ESP for particulate control, even if there is a high degree of mercury oxidation, the plant will still need PAC or some other kind of sorbent. So you still need to install a carbon injection system and a halogen injection system - but instead of two systems, why not use brominated carbon? One system is better than two, and you can get the same effect as a bromine system and some kind of sorbent.

"The same goes for a baghouse as well. If you have SCR or FGD such as a circulating dry scrubber, then you might not need to use carbon at all. You may have enough high oxidation of mercury either with SCR or halogen addition to coal, so it can be removed almost 100 per cent by FGD equipment. This will save a lot of money on capital costs, and to a certain extent on operating costs as well."

Chang notes that the capital cost is less intensive for mercury emissions reduction than for other pollutants. "Activated carbon is less capital-intensive than a wet FGD or SCR system," he says - but this is then balanced by operating costs "because you have to buy activated carbon from a vendor and [the cost of] injection is considerable." When selecting mercury removal technology, he advises that plant operators take into consideration both the capital and operating cost, including lifecycle costs, in order to "make sure they're not spending a lot of capital on a unit that won't have 20 years of remaining operation".

Heinz concurs: "The main driver for total cost of operation of mercury reduction systems is the ongoing OPEX - mainly the cost of sorbents. The CAPEX for installations is a secondary driver," he says.

When to implement?

Should plant operators wait until they are within the compliance period to purchase new mercury control equipment, or begin before the legislation comes into force?

Alstom's Grubbstrom says, "Those customers that have a large fleet need to look into the various options right now in order to spread out the investment. We have already had contact with customers - some larger utilities, for example - that would like to discuss it, even if it will be one year until the [BREF] is published and then [they can] take four more years [to upgrade]."

What does the upgrade involve, and how easy is it? Alstom's Heinz says his firm's technology is designed for upgrading existing plants. "We can implement it in the existing environment [as it is] not very space-consuming. Especially when the customer is currently on the way to implementing retrofit measures to improve the plant's performance, then he already has to consider the necessary steps for reduced mercury emission so as not to be in a position two years after a retrofit to start the next steps."

B&V's Chang says: "When you implement a compliance solution you have to take into account other anticipated future rules. We want to make sure our clients invest in a solution which will remain part of the overall compliance scheme in future."

Future developments

Current technology can remove around 90 per cent of the mercury emitted during the coal combustion process. Can this figure be improved - and could it ever reach 100 per cent?

MHPSE's Volmer says that, from a technology perspective, "I cannot say 100 per cent - I can say 99.999 per cent (just joking). It's a question between the possible technology and investment in its implementation," he explains. "If [power plant operators] have to comply [with standards], they have to invest or close down the plant. Reaching 99.99 per cent is possible, but it also has to be economically feasible. The operator may not want 99.99 per cent mercury removal technology."

Michael Wende, Process Engineering & Design AQCS with MHPSE, adds: "With the technologies required to cope with the regulations coming into force in 2016-17, a highly sophisticated standard for mercury removal will already be reached. In addition, the BREF revision in an eight-year cycle will be the driving force for additional efforts to improve mitigation technologies."

Emissions rules drive technology R&D

Volmer says his firm is working on a different composition of their product for different coal applications, aiming to increase the removal efficiency of mercury in the wet FGD system. "Our goal is not to build new equipment for modernization," he notes. "We want to improve existing equipment, which is more cost-effective for the operator. Our improved technology can reach up to 90 per cent. But this always depends on the incoming mercury in coal, and on the requested emissions values. The lower emissions values are necessary - they are the incentive for all technology improvement."

Wende adds that high US and European standards represent an impetus for continuous improvement in emissions reduction technology and optimized emissions mitigation in these regions. "However," he adds, "from a global point of view, one of the next required steps for emission reduction is to focus on the implementation of the applicable flue gas cleaning technologies in countries and regions with less stringent standards." For this purpose, he says "a huge portfolio of effective technologies is available."

(https://www.powerengineeringint.com/articles/print/volume-23/issue-11/features/mercury-falling.html)

CCS edges closer to commercialisation

Recent technological breakthroughs are fuelling hopes that CCS will fulfil its decarbonising potential, writes Frank Ellingsen of CO2 Technology Centre Mongstad.

The International Energy Agency estimates that fossil fuels will account for 60 per cent of energy generation by 2030, making carbon capture and storage (CCS) a vital technology for decarbonising the world's energy supply.

According to the United Nation's Intergovernmental Panel on Climate Change, exceeding a global temperature rise of 2°C would be 'catastrophic' for the global economy, and there has been international accord that a pathway to keep global warming within that level to 2050 must be set.

The IEA, the EU and the IPCC indicate that a fifth of the carbon reduction target needed to keep to the 2 Degrees Scenario (2DS) by 2050 could come from CCS alone. CCS is capable of reducing CO2 emissions from fossil fuel power stations by up to 90 per cent, so the race to commercialise and industrialise the technology is on.

Technology testing is necessary for verifying capture technology, which in turn reduces costs, plus technical, environmental and financial risks, thereby creating the preconditions for the industrialisation of CCS.

The UK Energy Research Council (UKERC), which spent two years researching the means for establishing CCS as a mainstream technology, came to the same conclusion: a regulatory approach making CCS compulsory in all fossil plants will only work if the technology is more advanced. So what are the greatest barriers from a technology perspective and what advancements have been made?

Energy companies and CO2 suppliers have been capturing CO2 in large-scale plants for decades; a technique that has been utilised in Enhanced Oil Recovery (EOR), as well as the production of commercial products like carbonated drinks. But capture remains the hardest aspect of CCS: up to 80 per cent of the costs of CCS are related to the capture process, so it is one of the main barriers holding the technology back from being developed at commercial scale. Currently, carbon capture is costly; the GCCSI estimates that each MWh supported by CCS costs energy generators an additional $50-100, as well as substantial capital costs for development.

To meet the need to evolve cost effective capture methods, CO2 Technology Centre Mongstad (TCM) a $1 billion joint venture part owned by the Norwegian government, Statoil, Shell and Sasol has been set up for vendors to test their technologies and to increase knowledge on capture technologies, in order to reduce technical and financial risk, and accelerate the development of qualified technologies which are capable of wide scale international deployment.

One of the technologies which has been tested since TCM opened in May 2012 is amine solvent carbon absorption, which has been tested in collaboration with technology partner, Aker Solutions.

In amine processing, CO2 is captured by an amine solvent, a liquid comprising water and amines, which is used to absorb the CO2 from the flue gas.

Amine technology has been used for decades in other applications and is therefore considered to have a moderate technical risk. However, at TCM the vendors will evaluate opportunities for improvements in process design, construction methods and operations with the purpose to qualify the technology for use in large scale post-combustion plants.
Based on the findings from the amine plant, TCM and Aker Clean Carbon have launched papers, which verify safe amine carbon capture from flue gases. The TCM amine plant is capable of processing 100 000 tonnes of CO2 per year. The sources are the a refinery with equal CO2 content to coal fired power plant and combined heat and power (CHP).
Off the back of the operational experience built up at among others TCM, Shell is developing Quest; one of the world's largest full-scale CCS project that will be operational in 2015. Shell is constructing the project on behalf of the Athabasca Oil Sands Project joint venture owners, which are Shell Canada Energy (60 per cent), Chevron Canada Limited (20 per cent) and Marathon Oil Canada Corporation (20 per cent). The project has also received funding from the governments of Alberta and Canada.
Beginning in 2015, Quest will capture more than one million tonnes per year of CO2 from Shell's Scotford oil sands upgrader near Fort Saskatchewan, Alberta, Canada - the equivalent of taking 175,000 cars off the road annually. The CO2 will be sent by an 80-km pipeline to a suitable storage site where it will be injected and permanently stored more than two km underground. Shell's patented ADIP-X amine-based capture technology has been a worldwide gas processing industry standard for extracting hydrogen sulphide and CO2 from natural gas for more than 40 years.
It is important to remember that CCS technology is an evolutionary process, which must be started now, to enable us to decarbonise existing fossil fuel reserves, as well as future fossil fuel excavations. As well as amine processing which is far along the evolutionary scale, and also chilled ammonia technology developed by Alstom, TCM's facilities enable future technology evolution, by providing the available area, utilities and infrastructure for the construction and testing of further carbon capture technology.
CCS technology has a vital role to play in the decarbonisation of global energy supply between now and 2050 and will have an even greater role to play beyond that, as unconventional energy sources take on an even greater resonance. It is not a case of if, but when these technologies are developed and the longer we wait, the more expensive they become. These projects will only work through the sharing of knowledge allowing each project to stand on the shoulders of the previous, in order to develop the market.
Recently, the world's first international test centre network for carbon capture test facilities was launched, to share knowledge and accelerate the commercialisation of technology. The key aims of the network are: to share technological developments, construction and operational experience, establish performance indicators, promote technology certification and standardisation. For the first time, a collaborative

playing field has been established allowing technologists to advance technology innovation, secure public support for and develop awareness of CCS benefits.

It is encouraging that technologies are advancing, and that knowledge sharing is taking place. The lead time for any new energy technology, from pilot to the beginnings of commercial deployment and then to materiality in the energy system (>1 per cent) typically takes some 25-30 years. That seems a long time, but the CCS industry also has in its favour the benefit of scaling up existing methods known to the oil and gas industry, such as amine processing. We cannot predict exactly which technologies will be used by 2050, but what is clear is that each of the various technology stages are vital for industrialisation, including the need for commercial demonstration programmes.

This process begins to de-risk the technology for future business investment, bringing some level of certainty to expected capital expenditure and ongoing operating costs. This evolution of technologies helps to establish infrastructure, which in turn lowers the cost for the next projects.

5000 hours and counting…

Since TCM's test activity started in July 2012, the facility has been in operation for more than 5000 hours.

The TCM core utility infrastructure has operated with more than 98 per cent availability and this has made it possible to supply the two absorption plants with exhaust gas and other utilities as requested by the two technology owners utilising the large scale test units.

TCM is currently testing Aker Solutions amine technology in the amine plant and Alstom Chilled Ammonia technology the ammonia plant.

Once the plants were tested and accepted by TCM, each vendor is allowed an agreed period to test and improve their technologies. The tests in the amine plant have been performed according to the vendor's test plan, with two different solvents, including transient tests and reclaimer operation. Similarly, testing, optimisation and modification of the ammonia plant is on-going in co-operation with Alstom.

As well as testing technologies, rigorous air sampling undertaken during plant operations has made a major contribution to CCS by gaining real life results from industrial testing related to the formation, degradation and dispersion of amine solvents. Based on the TCM programme, three scientific reports have been published, which for the first time have independently recommended the viability of safe amine carbon capture.

To enable technology verification, TCM's industrial-scale laboratory collects a vast amount of data from more than 4000 measuring points connected to online instruments. The lab tests around 100 samples each day, providing vital information on the selection and use of amine and ammonia chemicals for absorbing and releasing CO2 with minimum energy use. Instruments and sampling systems have been successfully verified and optimized, which is an important achievement for technology development and verification of CCS technologies.

A further development is that tests are soon to be performed with a solvent mix of the amine, monoethanolamine (MEA), and water.

An absorption process using MEA is used as a base case when different CCS technologies are evaluated and tested. The MEA based chemical absorption process is used as a baseline when comparing different carbon capture technologies. TCM's MEA test will provide a new and improved baseline from an industrial size 'lab' facility. The baseline will be valid for a variety of CCS applications, both in the process industry and in power production.

From 2014, the next round of testing of other absorption solvents will begin at TCM's amine plant, which is capable of processing up to 80,000 tonnes of CO2 per year. Aker Solutions, Hitachi, Mitsubishi and Siemens have all registered their interest in this first invitation cycle. Negotiations are currently underway to finalise the next users. TCM is also offering available space designated for installing further technology test unit(s), either for the construction of a new generation solvent test facility, or for entirely new technologies. Companies can register their interest for utilisation of this additional space with TCM until July 1 2013.

Vendor support for TCM

"At a time when so many full-scale projects are being delayed, the importance of R&D, testing and demonstration is even greater. TCM is unique in a global context. We believe TCM will play an important role going forward. The Norwegian government involvement is essential for TCM's existence."

Tore Amundsen, chief executive of Gassnova

"Our advanced carbon capture technology is being demonstrated every day at industrial scale with a high plant uptime and at a capture rate of the predefined 85-90 per cent. Results from emission monitoring campaigns at TCM have been excellent, which was one of the most important issues before scaling up the technology to full-scale carbon capture at Mongstad. We are very proud of this achievement."

Henning Østvig, senior vice-president, Aker Solutions

"We are proud to be part of the world's most advanced test centre for development of CO2 capture technologies. Our experiences so far with our Chilled Ammonia Process at Mongstad have confirmed our view of the Chilled Ammonia technology as a viable and very competitive technology."

Eric Staurset, country president, Alstom Norway

"CO2 Technology Centre Mongstad is a great asset to the worldwide CCS community. At a time when it is proving difficult to finance a large-scale CCS demonstration, due in part to the current economic concerns as well as uncertainty in climate policy, TCM provides a path forward for technological innovation."

(https://www.powerengineeringint.com/articles/print/volume-21/issue-5/opinion/ccs-edges-closer-to-commercialisation.html)

Building the next generation of energy-from-waste facilities

An increase in municipal solid waste and advancements in sustainable recycling have led to a growing need for energy-from-waste plants. Paul Gouland explores the challenges of delivering the next generation of large-scale projects

Backed by increased investment under the Public Private Partnership/Public Finance Initiative regime, the UK's energy-from-waste (EfW) capacity has grown considerably over the past decade, consuming around
12 mtpa of waste annually and generating some 5.57 TWh of electricity per annum, according to a report from Tolvik Consulting.
And with 27 million tonnes of municipal solid waste and 47 million tonnes of waste from businesses produced every year, there is huge potential for growth and further investment in the UK waste-to-energy sector in years to come.
Despite such significant growth, the UK still falls behind the rest of Europe when it comes to EfW. Across the European continent, there are currently 430 operational plants providing sufficient energy to power seven million homes.
Although questions have been raised about future capacity requirements – with Suez recently predicting a 14 million tonne shortfall in processing capability (contrary to a Eunomia report suggesting oversupply in EfW) – a predicted annual residual waste output of
6.8 million tonnes between 2017 and 2025 suggests there remains a strong case for waste-to-energy facilities.
Conventional EfW technology is now well established across the UK and Europe. However, as the processes involved with converting waste to energy continue to evolve, so do the facilities in which they are housed. In recent years, EfW plants have undergone a fundamental shift towards smarter, automated and more efficient working environments.
Constructing the new breed of EfW projects in the UK and Europe brings its own unique set of challenges. Today's modern facilities not only house a surplus of pioneering technology, from advanced turbines to automated material processing equipment and combustion apparatus, but also present several trials when it comes to their design.
Increasingly EfW plants are moving away from the traditional 'square box' designs and implementing modern architecture to build eye-catching facilities, which better depict the modern hi-tech facilities they house. This is especially the case when facilities are located within close proximity of residential areas, such as the UK and Europe's highly-populated cities.
Whilst the advent of such modern facilities presents considerable benefits for the UK's energy infrastructure, it also brings a number of challenges when it comes to building the next generation of plants. Modern construction companies, therefore, are adapting their building practices and techniques to meet the demands of the smart EfW plant.
One of the companies heavily involved in supporting the sector and delivering the next generation of plants is Clugston Construction. The company has established a strong track record of providing building and civil engineering services to the waste recovery and energy sector – stretching back to the company being established in 1937 when it set up an operation to recycle waste slag from the North Lincolnshire steel industries.

In more recent years the company has focused efforts on the mass burn market, working closely with French process specialists CNIM. Together, the firms have delivered a large number of major EfW plants across the UK.
The award-winning Leeds Recycling and Energy Recovery Facility (RERF) is a prime example of one such project. Awarded the Project of the Year at the National Structural Timber Awards, the innovative facility features a striking 42-metre-high arched timber frame which houses the process hall and is visible from many points of the city.
A mix of innovative and sustainable materials and techniques are incorporated throughout the construction and design, reflecting the environmental role the facility plays. The
123 metre-long and 35 metre-wide timber arch, for instance, is manufactured using Glulam laminated timber, one of the most sustainable construction materials available, whilst the building structure, in keeping with the environmental aspects, also includes a living green wall which is also believed to be the longest on any building in the UK.
Sustainability remains at the very core of the building's structure; in fact, the construction of the site also used recycled products in its foundations. The old concrete slabs which had been covering the brownfield site were broken up and crushed for reuse, which saved importing new aggregate and disposing of the old concrete to landfill, thereby cutting out hundreds of wagon movements.
Leeds RERF is more than just a remarkable architectural feat, however, with the facility having the capacity to divert and process approximately 214,000 tonnes of waste annually. Of this waste, around 20 per cent is recycled and the remainder incinerated to generate up to 15 MW of electricity, exported to the National Grid. The facility also has the potential to capture steam from the processes and provide it to local businesses in the district.
Wheelabrator Parc Adfer EfW plant in Flintshire, North Wales, is another example of a move towards a smarter waste-to-energy facility. Once constructed, it is expected to process up to 200,000 tonnes of non-recyclable waste per year that would have otherwise be sent to landfill, and to generate up to 19 MW (gross) of electricity annually for the National Grid. It will also be capable of providing valuable steam or heat to local industry and housing when plant operations commence in 2019.
Situated next to the Shotton Paper Mill, Clugston's building and civil works include construction of a 3300 m2 central process building, including a waste storage bunker which had to be cast in situ and a tipping hall which incorporates high speed roller shutter doors, as well as a 3722 m2 main boiler hall which incorporates bottom ash storage, flue gas treatment, turbine hall, and associated industrial waste water pit and electrical rooms.
Waste transported to the facility will go through an initial periodic inspection to ensure only acceptable waste is treated. Any recyclable materials such as cardboard, plastic or ferrous and non-ferrous metals will be removed. Following the initial inspection, suitable waste is loaded into the energy recovery facility by overhead

cranes and stored within large waste hoppers, from where it is fed into the integrated fast boiler units for combustion.
Integration of the building and process equipment has been fundamental to the construction of the facility. In order to house such advanced processing equipment, careful consideration has to be given throughout the design and build process, not only to ensure optimum performance, but also to safeguard employee safety. Clugston and CNIM utilized a range of collaborative software packages and BIM design protocols to ensure the facility not only met the requirements of Wheelabrator, but also the 30,000-plus homes to which it will supply energy.
Following the example of many plants across Europe, the objective of the UK government is to see EfW facilities connected to urban district heating networks. Although it presents countless challenges for developers in terms of planning, coordination and costs, locating EfW plants near existing or proposed heat networks, such as industrial and commercial sites, also presents countless opportunities – as demonstrated at Wheelabrator's Kemsley plant in Kent.
The new advanced plant is designed to process up to 550,000 tonnes of residential and business waste fuel annually – which would otherwise have been sent to landfill or pre-treated and then exported to European EfW plants – generating up to 50 MW (gross) of clean, renewable energy to power UK homes and businesses. The electricity generated is then exported to the National Grid transmission network with renewable steam supplied directly to the adjacent Kemsley Paper Mill, owned and operated by DS Smith. This will help to reduce the mill's reliance on fossil fuels, as DS Smith looks to decarbonize the production of recyclable packaging for the retail industry.
At Kemsley, Wheelabrator sought to utilize the latest advances in technology within the facility. As such, the plant will incorporate a two-line moving grate with a combined thermal combustion capacity of 100 MW.
Whilst the core elements of EfW plants are relatively consistent, the required process capacity, site constraints and local planning all impact the layout and building design. As a result, no two facilities are the same, with several eye-catching architectural and structural solutions recently being constructed.
(https://www.powerengineeringint.com/articles/print/volume-26/issue-6/features/building-the-next-generation-of-energy-from-waste-facilities.html)

Data centres: planning for power

The charge towards the cloud has helped fuel substantial growth in new data centre developments as well as expansion of existing facilities around the world.
Centralization, shared services and economies of scale are the name of the game now. That means even the largest of organizations need to build or leverage large data centre facilities to unlock savings or make use of processing and storage on-demand.
The modern data centre is therefore tasked with two key roles: delivering a seemingly-unending level of capacity; and maintaining high levels of operating performance.

Whether you are charged with building or remodelling a data centre exclusively for your organization, or doing the same for a larger shared services facility with multiple tenants, the same considerations apply. Planning is critical to ensure that you have and can deliver the capacity that people need, when they need it. Moreover, that you can deliver the performance levels expected, be that fast storage or processing horsepower, or simply the speed at which you can provision services when requested by a customer.

Modern data centres are vast and contain a substantial amount of technology. Yet the space is finite and there are thresholds that ultimately impose hard limits on just how much can be held inside one facility, and how the contents can operate effectively 24/7.

True capacity planning means being able to crystal ball gaze and predict future IT needs – what the data centre must provide in CPU cycles, storage, space, and power in order to support the business or, in the case of a shared services facility, support a broad range of clients scaling up and down across the year.

The latter is the real challenge. With a constantly fluctuating overall customer base, each with fluctuating demands, a degree of over-specifying of resources is needed to ensure enough of a reserve is on-hand when customer demand jumps, but not so much that if customers scale back, you as the data centre operator are left nursing costly over-capacity and recurring bills for bandwidth, energy, as well as the physical cost of unoccupied floor space.

Performance management

Data centres are growing in size and number in all markets, but particularly in the EU where existing and forthcoming legislation is having a profound impact on where data is stored. In-country data storage is creating substantial demand for additional data centre capacity across the region, particularly in markets such as the UK and Germany. This also means there is high demand for additional energy to power these data centres and the hardware sitting in them.

Compounding the challenge is the fact that as data centre demand and new site construction is sky rocketing, energy networks across Europe and elsewhere are under their greatest pressure to service demand.

There is only a finite amount of power available in a local electricity sub grid, potentially limiting the scope for a data centre to draw down as it reaches full capacity. In order for a local power provider to maintain continuity of service to everyone on the same subnet, including homes, hospitals and street furniture, a data centre may well find itself at the back of the power queue unless it has its own generating capability in the form of solar, wind or standalone generators.

With power demands growing, the extremely small margin for overcapacity in most electricity markets may not be able to fully satisfy the needs of the data centre, hampering business as well as operational performance.

Power needs

The peak power consumption of a data centre is a key consideration when architecting everything from the cabling to networking infrastructure, to how many server racks you place on each floor or segment of the facility. Get it right, and you will ensure that the facility can scale without interruption. Get it wrong, and you will fight a constant battle between a shortage of power and an inability to keep the facility cool enough to operate, itself putting further pressure on power needs and operating performance.

It is also a reason why deploying the latest, energy-efficient infrastructure technology is factored into capacity planning. Doing so will ensure energy use is as low as possible. Modern switches and interconnect technologies are now delivering substantial advances in power use, enabling them to deliver substantially lower power consumption per port or per Gb compared with previous generations of the same hardware.

Meticulous power performance monitoring and planning is needed because electricity generating capability across Europe is actually falling. This is due to the decommissioning of coal-fired power stations. The exception is France, which remains largely reliant on an established nuclear power programme and therefore has a much lower exposure to fossil fuel-based electricity generation.

This move away from coal, intended to improve air quality, is removing electricity generating capability from Europe's major nations at a rate faster than nuclear, solar, biomass, wind and wave power can fill the void.

For example, in the UK, generating capability has been steadily declining for over a decade. In 2014, data from the Department of Energy and Climate Change showed total electricity production stood at 335 TWh, while consumption was 302 TWh. This is down from peak generation of 385 TWh against consumption of 285 TWh in 2005. Add to this that energy prices have risen steadily from 2010. For data centres, this represents a major OpEx challenge to overcome and a dwindling level of grid capacity nationwide that can be leveraged for new and expanding facilities.

Data centres are not the only energy consumers having a big impact on local and national power infrastructure load. Everything from the growing Internet of Things to smart motorways are putting pressure on power grids.

Application performance

Any data centre ops team needs to focus on ensuring the performance of what is being served from the facility, whether its running on the customer's own hardware, or rented hardware provided by the facility itself. Maximizing the performance of cloud or private applications while maximising the use of available infrastructure. Every activity that is undertaken in a modern data centre including provisioning, monitoring, capacity management, and automation supports this goal.

With the advent of widespread server virtualization, the process of provisioning, deploying and configuring a server resource is increasingly a software action, rather than that of physically installing a server in a rack.

Nonetheless, the rise of virtualization has implications for data centre operators. Densely packed racks of physical servers all running at 100 per cent load, each with multiple virtual instances in play, will test any facility's ability. Be it to maintain operating temperature, deliver energy as well as ensure enough bandwidth is coming into the building to service traffic to and from those servers.

Tools for capacity planning

Capacity planning tools are essential for today's data centre operators to help them calculate the resources and power draw that a data centre will require, based on current and future projected use.

The tools for the job range from simple Excel spreadsheets to custom 3D renderings of the data centre floor map, complete with automated asset discovery, integration with power and cooling systems and other sensors around the facility. Sophisticated capacity management tools can even suggest outsourcing options when major power, space and cooling upgrades to the physical site are cost or time prohibitive. The same tools can also be used to provide information to customers of shared data centres, helping to automate some of the management of collocated hardware, or provisioning of virtual services on rented hardware.

Going forward, new and revamped data centre facilities need to be carefully architected to make most efficient use of the available resources. Alongside this, operators must ensure that high-energy functions such as cooling are up to the task.

Most critically, communications infrastructure will operate 24/7/365, with customers and end users expecting a consistent and high degree of operating performance and data throughput. This can't be compromised by overheating servers, power outages or an inability of a customer to scale up their installation on short notice to address a spike in demand.

(https://www.powerengineeringint.com/articles/2018/08/data-centres-planning-for-power.html)

South Korea flies flag for fuel cells

Korea's enthusiasm for fuel cells continues unabated, with domestic and international providers prospering in the market.

In economic terms, South Korea is a country quite unlike any other.

A largely agrarian economy until the middle of last century, the rise of its trillion dollar economy has been described as a miracle. Korea has become an economic superpower, propelled forward and upward by its leadership in electronics and semiconductors.

Now South Korea can claim another distinction: it is the new world champion in deployments of fuel cells for utility-scale power generation.

By latest estimates, its six generating companies have deployed almost 300 MW of fuel cell power to date, including the world's tallest, most energy-dense, and largest fuel cell parks.South Korea flies flag for fuel cells

The national fuel cell boom has its origins in Korea's Renewable Portfolio Standard. The RPS required all GenCos and Independent Power Producers with more than 500 MW of generating capacity to increase the proportion of power derived from renewable and 'new' technologies (including fuel cells and batteries) from 2 per cent at the start of this decade, to 10 per cent by 2023.

Responsibility for implementing the RPS has fallen to Korea's six generation companies, and the race between them to claim credits and avoid penalties, has given rise to some highly creative power projects.
For example, KOEN (formally known as Korea Southeast Power Company) recently built a triple-decker fuel cell park in Bundang, 25km to the southeast of Seoul. The park claims to be the world's most energy-dense power plant.
Colloquially known as the Bundang 'Power Tower', the design of the fuel cell park pays homage to neighboring high-rise residential apartments in what has become one of Seoul's most desirable exurbs.
The installation also claims another first: it is the first deployment of Solid Oxide Fuel Cell (SOFC) systems in the country, featuring 8.35 MW of SOFC-based Bloom Energy Servers.
The ambitious project is not out of character for KOEN, which is regarded as one of Korea's most progressive GenCos. KOEN has led in the adoption of robotics, artificial intelligence and other emerging technologies, which Korea refers to as the 'Fourth Industrial Revolution'.
While the country's love of technology has certainly inspired its leadership in the fuel cell domain, Korea's unique economy, topology, connectedness, and energy sector structure have also all contributed greatly.
Korea is the most densely populated of the world's major economies, with more than fifty million people inhabiting just 100,000 square kilometers, an area about the size of Kentucky or Iceland.
Its electricity consumption in kWh per capita is the highest in Asia, rivaling the US, and far exceeding that of France and Germany.
The day-to-day lives of Koreans are digital and power-hungry. Its population is one of the most connected: 85 per cent are online, and 88 per cent have a smart phone – the highest penetration in the world.
The price of real estate in the country factored significantly into the design of the Bundang Power Tower, which had to be deployed within the footprint of KOEN's existing combined thermal power plant.
To achieve the sought-after capacity within that footprint, the only way was up, and designers SK Engineering & Construction created the three-story structure to meet the challenge.
The KOEN Power Tower generates 1.34kW per square foot, or approximately one megawatt for each 787 square feet, a stunning advance of 3X in energy density versus the world's newest and most efficient combined cycle gas turbine plants.
To be clear, gas-powered centralized generation – as well as coal power - remains an important source of electricity in Korea. The country generates about two-thirds of its power from fossil fuels, and one third from nuclear power, according to KEPCO, the national utility.
However, two events in the country's recent energy history have accelerated the major overhaul of energy strategy.
In late 2012, several incidents of falsified nuclear power plant components emerged, fueling considerable anti-nuclear sentiment in a country that was already on alert

following the Fukushima nuclear disaster in neighboring Japan.South Korea flies flag for fuel cells
It was no surprise when a national energy plan unveiled in 2014 lowered targets for nuclear capacity.
Concurrently, Korea’s economic miracle had earned it a new, unwanted accolade: the country had become one of the world's top ten polluters, according to Reuters.
Its new energy plan therefore also promoted measures to reduce greenhouse gas emissions and fossil fuel imports by encouraging greater demand-side management, energy efficiency measures, and use of renewable and new energy technology.
President Moon Jae-in’s plan quickly became known as the ‘30-20’ plan by which Korea would seek to increase the amount of power it generated from renewable and new sources to 20 per cent by 2030.
So, why fuel cells? Well, remember that high population density? Korea is an extremely hilly and mountainous country, with only about 30 per cent of its area considered lowland. Its terrain and corresponding high property development costs make it largely unsuitable for large scale solar PV and wind power deployments.
Korea’s RPS has therefore provided the greater credits to GenCos for the deployment of energy-dense solutions, such as fuel cells and energy storage systems. GenCos receive twice as many RPS credits for fuel cells as they would for the deployment of solar PV.
Korea’s ubiquitous and well-maintained natural gas infrastructure has also supported the rapid proliferation of fuel cell projects.
While the rapid growth of the country’s fuel cell sector has provided valuable energy-dense solutions to Korea’s rising energy demand, it has also delivered notable opportunities for the world to evaluate the promise of each of the three main types of fuel cell technology.
All of the main types of stationary fuel cell have fundamentally the same promise: to generate electricity (and sometimes heat) from an electrochemical reaction between natural gas or hydrogen, and oxygen, without combustion. With efficiencies of approximately 60 per cent, the systems are energy-dense, and generally have lower greenhouse gas emissions than legacy fossil-fuel based generation.
It is the variations in the type of electrolyte used by the major fuel cell producers which impacts their price, performance and operating reliability.
For example, Solid Oxide Fuel Cells such as those deployed at Bundang generally operate at higher temperatures than other fuel cells, but also have the advantage of achieving the highest efficiency in terms of converting fuel to electricity, at up to 65 per cent.
The Gyeonggi Green Energy fuel cell park – a flagship project built by POSCO Energy in Hwasung City - uses molten carbonate fuel cells (MCFC). MCFCs have efficiencies in the high 40 per cent range, and can run on a variety of fuels, including coal-derived fuel gas, methane or natural gas, eliminating the need for external reformers. While MCFCs tend to have a lower upfront capital cost, their stacks tend to have a shorter life expectancy.

Meanwhile, the 31 MW fuel cell park developed by Korea Hydro & Nuclear Power to power 71,500 homes in Busan was built using phosphoric acid fuel cells (PAFCs) provided by Doosan. Like MCFCs, PAFC's have the benefit of being a source of both heat and power. However, fuel cell research firm Fuel Cell Today, describes PAFCs as having "lower efficiency than other fuel cell types in producing electricity".

A combination of capital cost, operating efficiency and fuel cell life expectancy seems most likely to determine the long-term winners and losers in the Korean fuel cell market.

In a country with no domestic gas supplies, where 100 per cent of fuel is imported as LNG via tankers, efficient use of fuel certainly matters.

However, fuel cell life expectancy has recently emerged as the most critical determinant of project success or failure.

For example, in a February 2018 article, Korean business newspaper DK Ilbo reported that of the 21 fuel cell units POSCO supplied to the Gyeonggi Geen Energy project, in less than two years, one third had stopped operating and required replacement.

The MCFC technology that POSCO had developed in Korea had failed to deliver the economically-critical five years of guaranteed quality, hurting the economic return of several POSCO fuel cell projects.

DK Ilbo reported that as a result of having to replace stacks prematurely, POSCO recorded a loss of 235.7 billion Korean Wan since 2014.

Not long after news of its losses emerged, POSCO announced that it would end its relationship with a US MCFC fuel cell maker and exit the fuel cell business entirely during 2018.

POSCO's exit was certainly notable, but its MCFC performance issues seem to have been unique to the GenCo's technology choice. Korea's enthusiasm for fuel cells continues unabated. Several domestic and international providers continue to prosper in the market.

The enthusiasm of those vendors will no doubt be buoyed by the Ministry of Trade, Industry, and Economy's 8th Electricity Supply Demand Plan which calls for expanding fuel cell deployments from today's ~300MW level to some 800MW by 2022.

(https://www.powerengineeringint.com/articles/2018/08/feature-south-korea-flies-flag-for-fuel-cells.html)

Green and economic credentials set to win wider audience for Ener-Core' Power Oxidizer

A recent meeting between Mike Cormier and a Manager at one of Los Angeles' 14 Air Quality Management Districts (AQMD) is instructive in understanding not just the incredible qualities of Ener-Core's new Power Oxidizer technology, but also how much the product's backers have to do to get the message out to the right audience.

"I was talking to him about the project and he kept staring at me until eventually I asked him if there was a problem," says Cormier, Director of Sales for the KG2 Gas Turbine and Power Oxidizer technologies for Siemens's Dresser-Rand business.

The AQMD Chief said, 'there's no problem, this is just too good to be true.'

"I said I agree - making power with less than 1ppm NOx, and with no post-exhaust treatment is pretty amazing. He replied that in his territory alone they have hundreds of flares. What we're hoping is once we get some hours on the reference units this will take off, as it's a power-generation solution that can literally eliminate flares.

While the technology now has a high profile reference case in the Pacific Ethanol Stockton 60 million gallon per year ethanol plant in Stockton, CA, it shows just how hard companies have to work to drive interest in a new technology, when its merits seem relatively obvious.

The conservative nature of the power industry means, regardless of the claims being made for the technology, they want to see a longer-term proof of it working in the field before committing.

To summarize, Ener-Core's Power Oxidizers are designed to replace the traditional gas-fired combustion chamber within) gas turbines. The resulting gas turbine solution enables industrial sites to convert their low-quality waste gases directly into useful clean power.

Under a license agreement with Ener-Core, the Power Oxidizer technology allows the Dresser-Rand business, part of Siemens Power & Gas, to provide industrial clients with a first-of-its-kind solution as a combined system with its KG2-3G gas turbine that can substantially reduce their purchases of energy from the grid while also reducing carbon and nitrogen oxide (NOx) emissions, and reducing the typical costs of running a pollution abatement system (flares, and others).

Right now, it's a proven technology with a high profile client. Once it becomes more established at that client, Cormier expects to see momentum in its fortunes.

"While we were building the Pacific Ethanol project we were also developing post-sales customers who are anxiously awaiting results and they're going to see them now," Cormier told Decentralized Energy.

"While no decision has yet been made, we are taking a look at the market and seeing if there is a need for the Power Oxidizer in larger gas turbines. Right now we are offering it at a 2 MW level and there is certainly a market for it at that size, though we're not yet sure just how large the market will be for larger units."

Industry versatility

While internal research continues into the suitability of the Power Oxidizer integrated within larger gas turbines, the Dresser-Rand business team is promoting the 2 MW standard to clients across a broad range of industries, many of whom are, up until now, oblivious to its virtues, but ideally placed to benefit greatly from its application.

"We are currently promoting it to landfills, wastewater treatment plants, and pharmaceutical companies among others that generate waste gas. There is also the automotive industry where they do a lot of high-volume painting and with this new solution, gas from the waste fumes can be used to generate power. This is uniquely a solution for using low quality waste gas fumes, but one of the challenges with new technology is client references. Everyone wants to see performance data for already running units."

"With it now under commissioning (at Pacific Ethanol) to make power and steam, we want to make use of this reference and establish a good size installed base. After that we could look at expanding up to the next size (megawatt turbines)."

Apart from the usual difficulty in bringing a new product to market, are there any other reasons that might explain why this product hasn't been heralded more?

"We're focusing on customers that have waste gases that they have little or no other use for. It's a matter of how much waste gases a customer generates, and you certainly have to have enough to operate the unit, which is what motivated Pacific Ethanol to install at its Stockton ethanol plant."

The Sacramento-based company has enough waste gas to operate approximately 6 per cent of their required gas requirements. Pacific Ethanol Stockton purchased two power oxidizers connected to two 1.8 MW combustion turbines with heat recovery steam generators and supplement a waste gas stream with natural gas. This creates a benefit to reduce operating cost of fuel supply, displacing expensive electricity purchases from the utility, producing low NOX electricity, and shutting down their previous pollution abatement system.

"If they're using 6 per cent less fuel in their gas turbine they'll still save a lot of money because once you get any type of gas turbine installed, whether it has a Power Oxidizer or not, your largest operating cost is fuel. In fact, it's fairly well recognized that 66-70% of the total life-cycle cost of a gas turbine is the cost of fuel, whereas the capital expenditure for the turbine only represents approximately 20-25% of the total life-cycle cost."

International opportunities

The Dresser-Rand business is keen to take the KG2-3G Power Oxidizer system into international markets. Even though ethanol is an area of breakthrough, that industry is relatively limited in the US.

Landfills are certainly a great fit and are numerous throughout the world. Although Europe, for example, is moving away in favour of digesters, landfills continue to produce gas for around 100 years after they are closed. Digesters also work well with the Power Oxidizer technology.

"Once you close a landfill, you've got enough volume of gas to operate a gas turbine or gas engine but only for a limited period of time – there is only enough high-quality methane for a minimal number of years after closure; whereas this technology can enable a closed landfill to continue generating power for decades."

"It can operate on very low energy fuels and the initial reviews show that we can extend the life of the landfill for producing electricity for probably 50 or 60 additional years beyond what a standard gas turbine or reciprocating engine is able to do. That's just free energy - 100 percent free gas that can be used productively to generate power with low to no emissions instead of flaring it off."

Environmentally and economically the product makes sense. When Power Oxidizers are installed, flares can be shut off and the client can make electricity with substantially less NOx emissions.- They are reducing emissions while simultaneously producing electricity, something a flare won't do.

ENER-CORE CHP from above

Similarly with the more prevalent digesters available today, the Power Oxidizer can use the waste gas produced and make electricity with ultra-low emissions.

"Pretty much every wastewater treatment plant around the world is using digesters now and those digesters are also forming gas that we can use in the Power Oxidizer and the beauty of it is that the Power Oxidizer is more tolerant to the H2S being generated in the digesters, so customers can potentially reduce the cost of clean-up. If you have H2S and you oxidize it, it turns into SO2 and SO3. You decide whether to take the H2S itself and the customer starts to have some options they can look at because fuel gas clean up can be incredibly expensive."

One recent example of where the Power Oxidizer was trialled by Ener-Core involved a landfill in the Netherlands where a 250 KW microturbine was utilised to good effect.

The available energy at the landfill was no longer enough to run the reciprocating engines, which would continually shutdown due to the low-quality of the gas. The installation of the Power Oxidizer allowed for re-commencement as it was capable of using the available lower quality gases.

Cormier says the potential for the Power Oxidizer technology may not remain under-appreciated for very long.

"I think people don't realise how much waste gas is out there, not just in North America, but throughout the world."

"What we, as a global society, are either flaring or venting into the atmosphere can be used to power the whole USA. We are trying to be as environmentally friendly as we can, but we are ignoring this potentially huge stream of waste gas, and are not realizing the significant benefits as we could."

"The fact is emissions are much higher from flaring than using a Power Oxidizer to eliminate those emissions, and the Power Oxidizer actually generates valuable energy, which results in a much more interesting equipment investment than an investment with associated flaring which is wasteful and adversely impacts the environment."

(https://www.powerengineeringint.com/articles/decentralized-energy/2018/05/green-and-economic-credentials-set-to-win-wider-audience-for-ener-core-power-oxidizer.html)

How energy bosses are underestimating the potential of intelligent automation

The global energy and utilities sector is embracing the use of intelligent automation, particularly artificial intelligence – but executives are still underestimating its full potential.

That's the verdict of the Capgemini Research Institute, which surveyed more than 500 energy business bosses and found that nearly half of them have under-estimated

the benefits they derived from their intelligent automation initiatives, while only 18 per cent are deploying quick-win use cases.
And just 15 per cent of those surveyed said their company is deploying multiple intelligent automation use cases at scale.
“Having tasted the benefits of automation, energy and utility companies must now redouble their investment to reap the full rewards,” said Philippe Vié, Global Head of Energy & Utilities at Capgemini.
A report based on the survey results highlights that the traditional energy and utilities business model is under pressure worldwide, with technological changes and increased competition making their presence felt. It cites that automation and AI will also be instrumental in helping these companies to meet climate change goals and the growing demand for clean, cheap, reliable energy.
The report also shows significant regional and sub-sector disparities in the scaling of automation. In the US, 23 per cent of energy and utility companies have deployed intelligent automation initiatives widely at scale, as have 16 per cent in both France and India, compared to just 8 per cent in the UK.
Capgemini says that while the sector is deriving significant value from intelligent automation compared to other industries, “scaling, seizing quick-wins and overcoming the critical digital skills gap will be key to bringing it into the mainstream”.
Philippe Vié said that the energy and utilities sector “is already seeing the difference that intelligent automation can make in improving business efficiency, customer satisfaction, and revenue. Executives are quite rightly making the deployment of automation one of their top priorities.”
However, he added that the focus must now “shift to the factors that will enable the scaling of multiple use cases including an investment in specialist talent, more integrated co-ordination between business units, and a stronger commitment from leadership.”
The study surveyed 529 leaders at manager level or above in energy and utility companies based in the US, Germany, India, the UK, France, Netherlands and Sweden. It found that the sector is already seeing significant value from automation, in terms of boosting operations, topline growth and engaging customers, compared to other industries. A consistently higher percentage of executives in the energy and utilities sector said they’d achieved benefits from their intelligent automation initiatives compared to the response for ‘all sectors’.
Abhijeet Bhandare, Chief Automation Officer at GE Power, explains. “We have a very clear filtering criteria defined for automation use cases. We have close to 200 automation ideas in the pipeline, and on average about 50 per cent to 60 per cent of them will be rejected. It is important to focus your attention on the remaining 50 per cent, as they will give you the most value. And you must have the right criteria – whether it is value, efficiencies, cost savings or the opportunity cost. Organizations should focus on quality over quantity of use cases.”
In core functions, Capgemini found that only 18 per cent of energy and utility organizations are deploying quick-win use cases – those that are low on delivery

complexity but high in terms of benefits achieved, such as forecasting, energy trading, yield optimization, grid behavior interfaces and complaints management. Instead, just over a third of the energy and utility organizations are focusing their efforts on use cases that are easy to implement but which have a low-benefit upside.
And while overall adoption of AI has matured in the sector, with 52 per cent of respondents having deployed a number of use cases, only 15 per cent of executives said their company was deploying multiple intelligent automation use cases at scale.
Business-related challenges were cited by respondents as barriers to scaling, including a lack of co-ordination across different business units, a lack of leadership commitment, and an organizational reticence to experimenting with technology that could replace human workers.
Many executives also pointed to a shortage in skills as a challenge. Some 55 per cent cited a lack of talent skilled in automation technologies, with 47 per cent identifying limited efforts to reskill employees, 42 per cent the difficulty of retaining employees with the right skills, and 41 per cent employee resistance to learning new skills.
(https://www.powerengineeringint.com/articles/2019/06/how-energy-bosses-are-underestimating-the-potential-of-intelligent-automation.html)

Digital transformation puts clean energy goals within reach

In March 2017, power generated from the sun and the wind reached a significant milestone in the US. For the first time ever, solar and wind energy accounted for 10 per cent of the country's electricity generation (8 per cent wind and 2 per cent solar), according the US Energy Information Administration.
According to the Solar Energy Industry Association, installation of solar generation capacity has grown at an average annual rate of 54 percent since 2006, while solar costs have come down 70 per cent since 2010, making them increasingly cost competitive with other resources. That's why nearly 60 per cent of installed solar capacity last year was utility-scale. It's also why some industry projections have solar and wind generation surpassing coal and nuclear on a combined basis as early as 2030.
These numbers and trends should not come as a surprise to anyone. The more pressing topic is how utilities are going to evolve their planning, operations and business models to enable this profound change and turn it into a growth opportunity.
Of course, solar and wind energy come with three key challenges. First, they are intermittent, when the sun sets or goes behind a cloud, or the wind stops blowing, there's no production, affecting up to 100 per cent of capacity for these resources. Second, these resources tend not to be co-incident with peak load. And lastly, significant resources are often located long distances from the loads they serve. While 10 per cent renewable penetration is proving entirely manageable, 30, 40, and even 50 per cent penetration (the goal of many state-level renewable portfolio standards) compounds the challenges. These challenges can be organized into three broad categories:

Forecasting: In an electricity market rich in renewables, it's difficult to overstate the importance of an accurate and timely demand forecast. The technical stakes (grid stability and power quality) and the economic stakes (the costs of procuring and summoning alternative generation resources) are significant. Accurate forecasting, including the system-wide and localized impacts of distributed generation, on a daily, hourly and even on a near-real-time basis in some cases, becomes an operational and business imperative. Thanks to high-resolution data sets, better algorithms, and statistically adjusted end use modeling tools, it's now possible to gather and apply this business intelligence at both bulk power and distribution system levels, significantly mitigating these risks.

Operations: To manage the challenges posed by intermittent and distributed energy resources, distribution utilities are going to need to extend visibility, intelligence and control to the edge of the grid. That means deploying connected, intelligent and secure devices -- from distribution automation equipment, to grid sensors to smart meters – ubiquitously throughout their networks. This includes enabling IoT capabilities such as distributed computing, artificial intelligence and machine learning to not only sense changing grid conditions and load volatility in real time, but to quickly take appropriate and coordinated corrective action in an autonomous manner. These capabilities will be critical to managing an increasingly distributed and intermittent resource portfolio.

Planning: After rising continually over the past two decades, investor-owned capital expenditures are projected to level off and even trend downward a bit in the next few years. That has big implications for grid planning. Depending on the location, you can either create problems or solve problems by deploying DERs. Utilities are going to have to migrate from a static to a dynamic grid planning approach that accurately reflects the impact and business value of renewable energy based on location. This will require utilities to adopt new planning tools and high-performance computing capable of modeling grid behavior and DER impacts on a system-wide and localized basis, along with business case models that capture the true value of renewables across a full spectrum of metrics. This will enable utilities to transition from mitigating renewable impacts to actually leveraging these assets to improve grid resiliency and reliability.

The evolving role of the CIO

In meeting with our utility customers, I often discuss how the role of the chief information officer is evolving closer to that of a Chief Digital Officer or "CDO," and how their organizations will benefit if they embrace the role. Computing resources and traditional IT functions are increasingly becoming commoditized, and as a byproduct so is the traditional role of the CIO, whereas technology investments are increasingly being applied to the front office or at the point of customer experience where it's literally helping the business transform to service new markets and products.

The management of horizontal and commodity IT services is increasingly an exercise in strategic supply chain management. With the advent of cloud computing (aka "utility computing") there are a plethora of technology options that will drive down

costs, increase uptime and enable CIOs to use the savings to self-fund new technologies that drive new business initiatives. Embracing these mediums to save money and spend it more wisely in new ways will impact the business materially.
And there's some irony in the fact that utilities are slow to embrace a business model (commoditizing of traditional IT and computing services) that their contemporaries in other markets have mastered over the course of decades to create headroom for new technology investment that increases business agility and enables more high-value, service-oriented offerings. Renewable energy represents an opportunity for utilities to re-invent themselves, redefine their growth strategy, and create new value for their customers and their shareholders.
Utilities can learn from digital transformation efforts in other industries
There's a playbook for this digital transformation. Many other sectors, their business models disrupted by new technology, innovation, and latent customer needs, have re-imagined their businesses and applied technology and data to drive new growth. We've seen it in banking, telecom, retail, and investing. I'm seeing more and more utilities charter cross functional working groups focused on developing new revenue streams, bringing new products and services to market, and turning the threats posed by customers generating their own power into growth opportunities by leveraging their brand as trusted energy advisors.
The characteristics of renewable energy require change: putting in place the technology, operational procedures, planning processes, and regulatory and policy reform to assure that the costs and benefits are allocated appropriately across the stakeholder community. Digital transformation of the utility represents the most important and fundamental step of harnessing the value these clean energy resources offer. Let's begin the journey.
(https://www.powerengineeringint.com/articles/2019/01/digital-transformation-puts-clean-energy-goals-within-reach.html)

How will the energy landscape change in 2019?

It's 2019 – that's nearly 2020! It doesn't seem long ago that the EU was setting what seemed like fairly radical targets for 2020; for decarbonization, for renewable energy use and for energy efficiency.
However, time runs fast and looking back, it was 12 years ago in 2007. Despite the good work by EU member states, concerns over climate change are growing and the expectation is these concerns will grow faster in the coming year.
Now we often talk of the three Ds of energy; decarbonization, decentralization and digitalization (sometimes a couple more Ds are added for good measure; deregulation and democratization). Do these three Ds have the same imperative?
Decarbonization of the power sector still seems fairly clear – the options haven't changed so much; energy efficiency, renewables, nuclear and CCS. Although, the costs and policies have changed enormously over time and renewables have made great advances.

For 2019 we can expect to see further advances and more geographies around the world in which renewables can out-compete traditional forms of generation and face the market more and more. This means renewables developers and investors getting comfortable with more market and less regulatory risk.

Decentralization and digitalization

Decentralization means different things to different people. For some its behind-the-meter investment, for others its generation and storage embedded in distribution networks. The drive for renewables produced a lot of energy from the latter as onshore wind and solar PV took off.

This decentralization trend is set to continue next year with a return in some countries to onshore wind. More battery storage will be built and it will be performing different roles. The first wave of batteries was fulfilling near instantaneous response requirements, but as that is saturated, batteries will provide response more generally and play a role in alleviating grid constraints. But pure energy arbitrage opportunities are some way off requiring greater levels of renewables on the system.

Behind-the-meter investment will continue into generation and storage but, as tariffs structures are reviewed and amended to be more cost-reflective, then care will be needed when making long-term investments. But decentralization is not an objective in itself, it is an outcome.

When thinking of the end user more corporate PPAs are expected, although solutions will need to be found to manage counterparty risks if these are going to form an enduring option for bankable renewable investments. In addition, some corporates need to understand better what they are signing up to. Ultimately it comes back to the market.

And so inevitably to digitalization

Over our working lives, change from digitalization has always been there. Laptops, email, the internet, vast improvements in computing power; plus and an increasing reliance on algorithms and access to more data than we can manage. And now the extremely high interest – and some would say hype – in digitalization.

But perhaps one's hope should be tempered by, for example, the utilities failures in the past to combine and manage simple customer data and billing systems adequately. What will they make of big data?

In last year's article looking to 2018, Steve Martin of GE quoted the IEAs Digitalization and Energy report as saying that digitalization could save 5 per cent of annual power generation costs.

Given the fall in renewable and battery technology costs we've witnessed, this doesn't sound very exciting; nor in the light of increasing volatility of commodity prices. Perhaps those technology cost falls have themselves have resulted from greater digitalization, but does that make the energy sector largely a recipient rather than a participant in the digitalization journey?

What can we expect from digitalisation in 2019?

The step-change that we see is two-fold: on the one-hand, computing power increasing and enabling greater levels of AI and machine learning; and secondly, the

amount of data available for those computers to analyse. These two combine to mean that better decisions are made and are also automated.
These are the key areas we expect to see further progress in 2019 in digitalization in energy:
Fault prediction and dynamic maintenance: This is one of the clearest uses of AI which enables operators to predict equipment failures by using sensor data from various units to significantly reduce their costs of downtime and maintenance. Pöyry has an offering for this called KRTI4.0. On the retail side, a startup Verv is offering a meter device which identifies individual home appliances and tries to predict faults or a device being accidentally left on by building up individual profiles from the meter data.
Investment optimisation: BP's venture arm invested in an AI startup called Beyond Limits to dig through seismic images and geological models to increase the chances of success when drilling wells. Another example of longer-term investment decisions is the US Department of Energy project where machine learning is being used on satellite imagery and operation data to prioritise reinforcement at vulnerable points of the grid to improve resiliency.
Energy efficiency: Deepmind, which is a part of Google, has championed the use of Reinforcement Learning to reduce energy use in its data centres by a claimed 15 per cent. The model learnt by looking at years of operational data and then issued changes to individual units within the operating constraints of the plant.
Better prediction: Deepmind is also currently in talks with National Grid of the UK to better forecast demand of the system with the stated goal of reducing the entire country's energy usage by 10 per cent. Another example is improved prediction of wind power production to reduce imbalance costs by 50 per cent which was achieved by a company called Swhere.
Trading: According to the FT, systematic and algorithmic trading now account for nearly 60 per cent of the traded volume on just the CME energy product group – highest level of any commodity group. Anecdotal evidence from mid-2018 is that over 50 per cent of trades on the EPEX Spot intraday market are algo-trades (although the total volumes are still smaller than trades executed by human). Sophisticated machine learning models are also being deployed by speculators which are relying on large streams of diverse data to respond to the market changes quickly.
A more commercial example is Origami Energy using machine learning to predict asset availability and balancing mechanism market prices in near real time to successfully bid into the Frequency Response markets. Pöyry is exploring a deep learning algorithm to support trading and dispatch decisions for generation assets in the prompt trading markets, focusing on the issue 'when should I commit a trade' (to maximise the option value of flexible capacity).
Retail: retailers are using machine learning to understand patterns of customer behaviour, to attract and retain customers and even to predict bill (non)-payment. Customer call centres are being fronted by algorithms which chat to customers (verbally or online) and deal with queries.

Customers: For customers, AI solutions are also gaining traction, and many retailers are offering these systems as part of an integrated package. Devices such as Amazon's Alexa enable the customer to seamlessly interact with their thermostat (such as Centrica's Hive). This increasing customer interaction with the device leads to the development of a more personalised usage profile, which reduces bills for the consumer and also helps the energy provider to accurately forecast demand.
It would seem then that the digitalization opportunities in energy are large. It will be a vital enabler of decarbonization is some areas in the future such as flexible demand shifting to meet supply.
The opportunities available rely heavily though on sufficient volumes of good quality data being available. So, expect more sensors and more data acquisition throughout the energy sector in 2019. And in time with growing autonomy expect the focus to switch to the appropriate monitoring, alerts and controls.
As succinctly put by computer scientist Andrew Ng: "AI is the new electricity – enabling us to do more."
(https://www.powerengineeringint.com/articles/2019/01/how-will-the-energy-landscape-change-in-2019.html)

Emerging digital patterns for the next-gen energy market

This article discusses the emerging design patterns for the next-gen energy market and carbon energy tokens, all of which seek to serve the goal of meeting global zero carbon emissions
The climate change act of 2008 has mandated the UK to reduce greenhouse emissions by at least 80 per cent by 2050.
Recently, a legislation has been passed in the UK making it mandatory for private heavy industries to declare carbon reporting as part of their annual fiscal reports with effect from April 2019. These are reminders to accelerate the drive towards carbon neutral economy of the new Digital future.
The traditional electricity production, transmission and distribution pattern which has been primarily unidirectional in flow of value is slowly diminishing. The new age paradigm is multi-directional, distributed grid with many application programming interface (API)-enabled integration touchpoints with customers, value-added service providers such as suppliers, and connected Internet of Things devices.
As the API economy matures with greater secured interoperability between businesses, large residential communities, IoT device manufacturers of smart meters and better ability to control and balance the digital grid, the possibilities of the next generation of Energy market is immense.
The emerging design pattern for the next gen energy market would be based on the four core principles:
· Interoperability with open an API which is secured and complied to energy data communication standards
· Decentralisation of transactions to enable more participation by customers be it at industrial scale, or by medium to large communities of distributed producers

· Motivation for digital energy market participants to monetise energy that is being sold to the distributed grid using renewables and earning carbon credits from them
· Control and transparency at the fingertips of the next generation communities who can see for themselves the power of digital data and business analytics
The new grid economy combined with new age technology catalysts such as distributed ledger technology, IoT & edge computing and machine learning will pave the way for rapid realisation of industrial scale solutions in the digital power sector.
The energy suppliers, regulators, carbon exchange traders and large to medium-scale manufacturers can all mutually gain from the participation in the new age energy ecosystem.
EU Emissions Trading System has been the EU strategy for reducing greenhouse gas emissions from industries and power sector. It contributes significantly to the EU target of cutting GHG emissions by 20 per cent 1990s to 2020s.
The strategy involves: Capping allowances on GHG put in circulation over a trading period. The cap reduces each year by 1.74 per cent year on year; Achieving emissions targets; Following a framework for common, robust accounting rules; Linking of multiple ETS across EU zones enables one system to use units from another system for compliance (EU & Switzerland are planning to link their ETS); and harmonizing carbon pricing.
The Emission Trading System sets carbon emission cap for the majority of large and medium scale manufacturing plants in the EU across 25-member nations. The current Phase 3 of the EU ETS (currently in effect from 2013 till 2020) aims to reduce the carbon emission cap across EU and extend the low carbon emission scheme to different industry segments which were previously outside its ambit such as aviation, shipping, production of metals such as aluminium and hospitals in the UK.
A novel scheme has been introduced to ensure carbon credit allowances are auctioned in the market to encourage competitiveness amongst carbon intensive industries to adopt Clean Development Mechanisms.
In the above context, it makes sense to have carbon emission regulation agencies who control and monitor carbon allowances against the specified cap as well as the broader carbon exchange traders, energy suppliers and manufacturers to be a part of a common digital platform.
This very common platform can enable various entities to buy and sell carbon tokens amongst each other. A typical value chain can be realised as follows:
Large Manufacturing Organisations can be enabled by the digital platform to buy and sell renewable energy at competitive tariffs and claim carbon credits. In case these organisations have capability to store excess energy then it can be easily monetised using crypto carbon tokens.
Carbon Exchange Traders can be enabled by the digital platform to aggregate excess units of energy to anyone who needs carbon offsetting, including manufacturers, energy suppliers and producers, and even individual homes.
There is also a great deal of carbon consumption vs generation pattern that can be analysed for predictive and prescriptive purposes. The sources of data can be provided by smart IoT devices through an IoT hub. Potential big data analytics can

predetermine carbon trade cap and allowances that will be necessary to maintain carbon pricing balance and fairness in trade. It would also help in rewarding industries adopting cleaner and greener development techniques and imposing penalties on carbon offenders.

The Distributed Ledger Technology can enable each of the carbon ecosystem entities to register on a common platform and execute carbon trade on a real time basis. The issuance of digital carbon certificates to prove the authenticity of the carbon sellers can be achieved through third party digital notaries or the platform itself.

This will result in reducing the cycle time for carbon token exchange between multiple businesses where each party can instantly report to the broader ecosystem on its contribution to the low carbon economy.

The different enablers for realising a digital platform for the new age energy market essentially comprises of blockchain nodes where each node can represent the different entities and smart contracts for the different carbon trading algorithms.

The renewables energy tokens would be traded between multiple parties and settled in real time. The carbon reporting system would be tightly integrated with the platform for every buyer and seller and get updated instantly upon settlement.

The rapid democratisation of carbon token exchange between those with excess and those in need with minimal overhead and zero manual intervention will pave the way for accelerated low carbon economy that, the United Kingdom, EU and the rest of the free market economy aspires to achieve.

(https://www.powerengineeringint.com/articles/2018/12/emerging-digital-patterns-for-the-next-gen-energy-market.html)

Electrification and renewables boom across Europe will require huge grid resilience

Grid companies will need to deliver around 90 GW of new transmission lines across Europe by 2040 to cope with a boom in renewables generation and a significant surge in the electrification of transport and heating.

And this huge grid upgrade will need to be complemented by a range of flexible power sources, including gas engines, storage, and demand flexibility.

That’s the conclusion of new research published today that claims that renewables will provide over 60 per cent of Europe’s total power supply by 2040, representing a 400 GW, €400bn investment opportunity into clean energy capacity.

And the study adds that by 2050, total European power demand could rise by as much as 85 per cent, mainly due to the electrification of heating and transportation.

The findings by energy market analysis firm Aurora Energy Research highlight a rapid shift towards electric vehicles and renewable generation in a highly-interconnected European grid.

“The European power system is set to change dramatically in the coming decades as a result of the drive to reduce our carbon emissions, as well as the electrification of transportation and possibly heating,” said Richard Howard, research director at Aurora.

He added that of the anticipated 400 GW of renewables generation capacity to be deployed across Europe between now and 2040, “much of this will be delivered without government subsidies, as the falling cost of renewables brings them to grid parity”.
“Making this a reality will require significant investment in grid infrastructure and flexible capacity, as well as ongoing policy and regulatory reforms to ensure that this is delivered at the lowest cost to consumers.”
The report was unveiled today at Aurora Energy Research’s Spring Forum event in Oxford, England, and it states that taking ‘merchant risk’ on renewables projects has become a necessity in most European countries as subsidies are being withdrawn.
It adds that this puts significant value at risk for developers and Europe as a whole, but adds that major corporate energy users could play a crucial role in carrying some of this market risk through the provision of long term power purchase agreements (PPAs).
“In Germany alone we estimate that PPAs with major industrial power users could bring forward 12 GWs of new renewable capacity,” states Aurora. “For renewables developers and utility companies, understanding industry off-takers and building products and relationships fit for their needs will be a key competitive advantage in the next five years.”
Alongside the growth in renewables supply, Aurora also predicts a significant increase in power demand due to the electrification and digitalisation of many aspects of economies and society.
In particular, the analysis shows that electric cars are rapidly entering the mainstream, with more than 25 per cent of new cars launched in Europe this year being battery electric or hybrids. Aurora predicts that almost full electrification of personal and light commercial transportation could be achieved by 2050, increasing power demand across Europe by approximately 20-25 per cent above current levels.
Electrifying heating is also anticipated to see significant growth, but the report warns that this “would place even more significant demands on the power system, both in terms of the amount of electricity required, and due to the fact that heating demand is concentrated on colder days during the winter months”.
“Taken together, the electrification of heating and transport could result in as much as an 85 per cent increase in power demand across Europe.”
(https://www.powerengineeringint.com/articles/2019/03/electrification-and-renewables-boom-across-europe-will-require-huge-grid-resilience.html)

ЗАКЛЮЧЕНИЕ

Настоящий практикум направлен на формирование у обучающихся представления о сущности процесса технического перевода, основных принципах и понятиях теории и практики технического перевода; формирование умений и навыков, необходимых для качественного перевода технического текста с английского языка на русский.

Авторы надеются, что предлагаемое издание будет способствовать успешному овладению студентами программы курса «Иностранный язык (технический перевод)».

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ПРИЛОЖЕНИЕ 1

МЕТОДИЧЕСКИЕ УКАЗАНИЯ ДЛЯ ОБУЧАЮЩИХСЯ

Для успешного усвоения обязательного материала, предусмотренного учебной программой и государственным образовательным стандартом, необходима самостоятельная работа студентов в виде планомерного и регулярного выполнения домашнего задания.

Цель самостоятельной работы: совершенствование знаний, умений и навыков в процессе письменного и устного перевода и применении полученных знаний на практике.

Самостоятельная работа студентов предусматривает:

- подготовку к практическим занятиям: изучение основной и дополнительной литературы, исходя из тематической направленности и задач дисциплины;
- изучение материалов практических занятий с целью формирования умений и навыков практического перевода;
- ведение глоссария;
- работу со словарями, справочниками и интернет-ресурсами;
- выполнение устных и письменных упражнений по формированию различных навыков;
- использование поискового, изучающего, ознакомительного и просмотрового чтения при работе над источниками; систематизирование материала с целью предъявления;
- реферирование и аннотирование текстов;
- редактирование текстов (исправление фактических, языковых, стилистических и других ошибок и недочетов);
- подготовку к контрольным работам и зачетам.

Общие методические указания по подготовке к практическим занятиям.

1. Изучить соответствующий теоретический материал, используя конспекты занятий, основную и дополнительную литературу.
2. Осуществить самоконтроль и самооценку проделанной работы.
3. Выполнить практические задания, данные для самостоятельного выполнения.

Методические указания по подготовке рефератов, докладов.

Реферат – краткое изложение содержания одного или нескольких источников, раскрывающих определенную тему.

Компоненты содержания:

1. План.

2. Введение (постановка проблемы, объяснение выбора темы, ее значения, актуальности, определение цели и задач реферата, краткая характеристика используемой литературы).
3. Основная часть (каждая проблема или части одной проблемы рассматриваются в отдельных разделах реферата и являются логическим продолжением друг друга).
4. Заключение.
5. Список литературы.

Доклад – публичное сообщение на определенную тему, в процессе подготовки которого студент использует те или иные навыки исследовательской работы.

Компоненты содержания:

1. План работы.
2. Систематизация сведений.
3. Выводы и обобщения.

Методические указания по редактированию текстов

1. Ознакомиться с тематикой редактируемого текста.
2. Подготовить необходимые словари и справочную литературу.
3. Сравнить текст оригинала и текст перевода. Обратить внимание на качество перевода, содержание и стилистическое соответствие текста перевода тексту оригинала.
4. Обеспечить графическое и лексическое единообразие различных элементов текста.
5. Уделить особое внимание формулировкам, формулам и таблицам. Обозначения перевести в метрическую систему мер. Терминологию и лексику использовать такие, которые приняты в стране, для которой делается перевод.
6. Внесенные изменения согласовать с переводчиком.

Методические указания по реферированию и аннотированию текстов

Реферирование – краткое изложение содержания источника информации с указанием на характер, методику и результаты исследования. Реферат должен указать, чем именно отличается новое, данное в источнике, от методов и средств, применяемых ранее в соответствующей области.

Рекомендуемая последовательность выполнения работы по составлению реферата:

- просмотровое (или ознакомительное) чтение с целью выявления тематики текста;
- повторное чтение текста;
- смысловой анализ текста с целью выделения наиболее важных фактов;

- внимательное просмотровое чтение отрывков, заключающих в себе наиболее важную информацию;
- составление плана реферата;
- языковая обработка и письменное изложение реферата.

Аннотация – краткая справка о печатном произведении, его общей характеристики, сведениях о его ценности, об авторе. При аннотировании текста также вычленяется главная информация, содержащаяся в источнике.

Точного понимания текста и всех его существенных положений не требуется. Аннотация должна быть небольшой по объему.

Рекомендуемая последовательность выполнения работы по составлению аннотации:

•просмотровое (или ознакомительное) чтение с целью получения представления об общем содержании источника;

•повторное чтение отрывков и предложений, содержащих главную информацию;

•языковая обработка и письменное изложение информации в идее краткой характеристики источника по следующему плану: входные данные, основные положения и дополнительные сведения.

ПРИЛОЖЕНИЕ 2

Порядок работы над текстом научно-технической литературы

1. Просмотрите весь текст или абзац и постарайтесь понять, о чём идёт речь.

2. Проанализируйте предложения. Если предложение сложное, разбейте его на отдельные предложения:

- сложноподчинённые – на главное и придаточное (придаточные);
- сложносочинённые – на простые.

Предложения отделяются друг от друга чаще всего союзами.

3. Большинство предложений научно-технического текста – повествовательные, в которых твёрдый порядок слов (за исключением некоторых случаев):

- на I месте – подлежащее (группа подлежащего),
- на II месте – сказуемое (группа сказуемого),
- на III месте, сразу после сказуемого – дополнение (если оно есть в конкретном предложении),
- на IV месте – обстоятельства: места, затем времени (Иногда обстоятельства выносятся на так называемое нулевое место, то есть перед группой подлежащего).

4. Начинайте анализ предложения с поиска группы сказуемого. Его легче всего найти по определённым признакам.

5. Слева от сказуемого – группа подлежащего. Найдите его.

6. Справа от сказуемого – дополнение, затем – обстоятельства. Таким образом, твёрдый порядок слов помогает нам найти все члены предложения.

7. Начинайте перевод всего предложения с перевода подлежащего

8. Прежде чем начинать поиски перевода отдельных слов в словаре, уточните, какая часть речи вам нужна в данном предложении.

ПРИЛОЖЕНИЕ 3

Этапы работы над полным письменным переводом

1. Знакомство с оригиналом. Внимательное чтение всего текста с использованием, по мере надобности, рабочих источников информации: словарей, справочников, специальной литературы. Прежде, чем начать перевод, необходимо понять, что выражено на языке оригинала. Для этого следует внимательно, и может быть не один раз, прочитать весь текст. Помните, замысел автора выражен с помощью всего текста.

2. Выделение логических частей оригинала. Деление текста на законченные смысловые отрезки - предложения, абзацы, периоды. Следует помнить, что величина определяемой для перевода части текста зависит от 3-х факторов: смысловой законченности, сложности содержания, возможностей памяти переводчика. Такой частью текста может быть предложение, группа предложений, абзац, 1/2 абзаца и т.п., но эта часть должна быть обязательно законченной по смыслу. Чем сложнее текст - тем меньше такая часть, чем лучше память переводчика - тем она больше.

3. Черновой перевод текста. Последовательная работа над логически выделенными частями оригинала. После того, как содержание выделенной части текста понято и усвоено, его нужно выразить по-русски. При письменном изложении важно полностью отвлечься от оригинала, т.к. нельзя читать и думать на одном языке и одновременно писать и думать на другом.

4. Повторное (неоднократное) чтение оригинала, сверка его с выполненным переводом с целью контроля правильной передачи содержания. После того, как письменно изложено содержание выделенной части текста, нужно обратиться к оригиналу для сверки. При переводе последующих частей текста необходимо постоянно следить за стилем, т.е. за качеством, единообразием и логикой изложения. Единообразие терминологии должно соблюдаться на протяжении всего текста. Например, если в начале текста часть корпуса какого-то агрегата названа “дном”, то в дальнейшем нельзя называть ее “основанием”, “днищем” и т.п. Необходимо постоянно следить за тем, чтобы между каждой последующей и предыдущей частью перевода была логическая связь.

5. Окончательное редактирование перевода с внесением поправок. Помните, окончательно отредактировать перевод – значит стилистически обработать его в целом.

При редактировании целесообразно руководствоваться следующими правилами:

а) если одну и ту же мысль можно выразить несколькими способами, то предпочтение отдается более краткому способу;

б) если слово иностранного происхождения можно без ущерба заменить словом русского происхождения, то переводчик обязан это сделать;

в) все термины и названия должны быть строго однозначны.

6. Перевод заголовка. Перевод заголовка должен отражать суть содержания текста, статьи, патента и т.п. Поэтому заголовок переводится в последнюю очередь с учетом всех особенностей текста.

ПРИЛОЖЕНИЕ 4

Инструкция по выполнению полного письменного перевода

Прежде, чем начинать перевод, прочитайте весь текст, абзац или законченную часть текста; постарайтесь понять общее содержание текста.

- Прочитайте текст второй раз по отдельным предложениям, попытайтесь понять синтаксический строй и смысл каждого предложения. Переведите текст по предложениям.
- Если синтаксический строй предложения Вам не ясен, и Вы не поняли смысл предложения, сделайте грамматический анализ: определите вид предложения, найдите подлежащее, сказуемое, второстепенные члены. Если предложение сложноподчиненное, найдите главное и придаточное предложения, опираясь на формальные признаки.
- Обращайтесь к словарю в том случае, если Вы использовали все средства раскрытия значения незнакомых слов, включая догадку и грамматический анализ.
- При переводе последующего предложения необходимо постоянно удерживать в памяти смысл предыдущего, иначе теряется логическая связь между отдельными предложениями.
- Избегайте дословного перевода. Постарайтесь передать мысль оригинала средствами родного языка, не нарушая его синтаксического строя.

ПРИЛОЖЕНИЕ 5

Инструкция для нахождения исходной формы слова

Чтобы найти исходную форму слова, нужно отбросить грамматическое окончание.

1.Если перед окончаниями -(e)s, -e(d), -(e)r, -(e)st стоят буквы g, c, v, отбросьте лишь -s, -d, -r, -st. Например: *changes* - *change; placed* - *place; larger* - *largest* - *large.*

Если слово оканчивается на -ing, то -ing отбрасывается и добавляется буква -e, например: producing - produce.

2. Если перед -(e)s, -e(d), -(e)r, -(e)st стоит буква i с предшествующей согласной, отбросьте окончание, а букву i замените на y. Например: *supplies* - *supplied* - *supply; earlier* - *earliest* - *early.*

3.Если в односложном слове перед -ing стоит буква y, отбросьте окончание - ing, а букву y замените на ie. Например: *lying* - *lie; dying* - *die.*

4.Если перед -e(d), -(e)r, -(e)st стоит удвоенная согласная, отбросьте окончание и одну из удвоенных согласных. Например*: stopped* - *stop; hotter* - *hot; getting* - *get.*

Удвоенные согласные dd, ll, ss сохраняются после отбрасывания окончания, например: *called* - *call; adding* - *add; passed* - *pass.* Во всех остальных случаях окончания отбрасываются полностью; корневая часть слова остается неизменяемой, например: *tested* - *test; examples* - *example*.

ПРИЛОЖЕНИЕ 6

Список принятых сокращений

Сокращение	Полное обозначение	Перевод
abr,	abridgment	краткое изложение
a. h.	ampere-hour	ампер-час
a. т .	ante meridiem (лат.)	до полудня
amp	ampere	ампер
at. wt	atomic weight	атомный вес
b. p.	boiling point	точка кипения
Вг. P.	British Patent	Британский патент
b. s.	both sides	1. обе стороны, двусторонний; 2. смотри на обороте
bu	bushel	бушель = 36,3 л
C.	centigrade	стоградусная температурная шкала (Цельсия)
c.	cent	цент
cal	calorie	калория, грамм-калория
cap	capacitance	1. емкость; 2. емкостное сопротивление
c. c.	cubic centimeter	кубический сантиметр
C. C. W.	counterclockwise	против часовой стрелки
cf.	confer	сравни
Cfm	cubic feet per minute	кубических футов в минуту
Cg	center of gravity	центр тяжести
Ch.	chapter	глава
cu.	cubic	кубический
cw	clockwise	по часовой стрелке
d.	density	плотность
db	decibel	децибел
d. c.	direct current	постоянный ток
deg.	degree	1. степень; 2. градус
doz.	dozen	Дюжина
Dwg	drawing	чертеж, рисунок
e. g.	exempli gratia (лат.)	например
E. M. F.	electromotive force	электродвижущая сила
etc.	et cetera (лат.)	и так далее
F	Fahrenheit	температурная шкала Фаренгейта
f.	1. feet, 2. Foot	1. футы; 2. Фут
fig	figure	рисунок, чертеж
FM	frequency modulated	частотная модуляция
f. p. m.	feet per minute	футов в минуту
f/s	factor of safety	коэффициент безопасности, запас

		прочности
GAT	Greenwich Apparent	истинное время по Гринвичскому
	Time	меридиану
Gr	Gramme	грамм
hf. h.	half-hard	средней твердости
Hi-Fi, hi-fi	high-fidelity	высокая точность
h. p.	horse power	лошадиная сила
i. e.	id est (лат.)	то есть
Kg	kilogram	килограмм
Km	kilometer	километр
kw.	kilowatt	киловатт
kwhr.	kilowatt-hour	киловатт-час
l.	litre	литр
lb.	libra (pound)	фунт (453,6 г)
LH	left-hand	левый, левосторонний, с левым ходом
m.	metre	метр
mi	mile	миля
mm	millimeter	миллиметр
mol. wt.	molecular weight	молекулярный вес
m. p.	melting point	точка плавления
m. p. h.	miles per hour	миль в час
N	normal	нормальный
No.	number	номер
o. d.	outer diameter	внешний диаметр
P.	power	мощность
p. m.	post meridiem (лат.)	(во столько-то) часов пополудни
p. s.	per second	в секунду
psi.	pounds per square	фунтов на квадратный дюйм
R. H.	inch	
r. p. m.	relative humidity	относительная влажность
sp. gr.	revolutions per minute	оборотов в минуту
sq. ft.	specific gravity	удельный вес
tn	square foot	квадратный фут
vol.	ton	тонна
vs.	volume	том
yd.	versus (лат.)	против; в сравнении с
	yard	ярд

ПРИЛОЖЕНИЕ 7

Чтение формул на английском языке.
Reading formulae

Addition (Сложение)

a + *b* + *c* is read:

a plus *b* equals *c*;
a and *b* is equal to *c*;
a added to *b* makes *c*;
a plus *b* is *c*.

a, b are called “addends” or “summands” (слагаемые);
c is the “sum”.

Subtraction (Вычитание)

4 – 3 = 1 is read:

three from four is one;
four minus three is one;
four minus three is equal to one;
four minus three makes one;
the difference between four and three is one;
three from four leave(s) one.

4 is called “a minuend” (уменьшаемое);
3 is “a subtrahend” (вычитаемое);
1 is “a difference” (разность).

Multiplication (Умножение)

2 x 3 = 6; 2 · 3 = 6 is read:

two multiplied by three is six;
twice three is six;
three times two is six;
two times three make(s) six.
5 · 3 = 15 is read:
five threes is (are) fifteen.

2, 5 are “multiplicands” (множимое);
3 is “a multiplier” or “factor” (множитель);
6, 15 are “products” (результат).

Division (Деление)

35 ÷ 5 - 7 is read:

thirty five divided by five is 7;
five into thirty five goes seven times;
35 divided by 5 equals 7.

35 is “a dividend” (делимое);
5 is “a divisor (делитель);
7 is “a quotient” (частное).

Involution or Raise to power (Возведение в степень)

3^2 is read:

three to the second power;

3 squared.

5^3 is read:

five cubed;

5 to the third power;

5 to power three.

x^2 – x is called the "base of the power";

2 is called "an exponent or index of the power".

Evolution (Извлечение из корня)

$\sqrt{9} = 3$ is read:

the square root of nine is three.

$\sqrt[3]{27} = 3$ is read:

the cube root of twenty seven is three.

$\sqrt{\ }$ is called "the radical sign" or "the sign of the root".

To extract the root of … - извлекать корень из…

Fractions (дроби)

1/9 - a ninth, one ninth

3/7 – three sevenths

5/8 – five eighths,

$\frac{2}{123}$ - two one hundred and twenty-thirds

3/4 - three quarters, three fourths

34/78 - thirty-four seventy-eighths

2/3 - two-thirds, etc.

3 2/5 – three and two fifths

10 2/7 – ten and two sevenths

5 1/2 - five and a half

7 1/3 - seven and a third

247 86/93 - two hundred and forty-seven and eighty-six ninety-thirds

347/1000 - three hundred and forty-seven thousandths

The reading of small fractions is often simplified:

1/2 - a half, one half

1/3 - a third, one third

1/4 - a quarter, one quarter, a fourth, one fourth

Reading formulas (чтение формул)

a ÷ b = c	*a* divided by *b* is equal to *c*
2 x 2 = 4	twice two is four

$c \times d = b$ *c* multiplied by *d* equals *b*

dx differential of *x*

$\frac{a+b}{a-b} = \frac{c+d}{c-d}$ *a* plus *b* over *a* minus *b* is equal to *c* plus *d* over *c* minus *b*

$y_{a-b} \cdot x_{b-c} = 0$ *y* sub *a* minus *b* multiplied by *x* sub *b* minus *c* is equal to zero

$\frac{d2y}{ds2} + [1 + b(s)]y = 0$ the second derivative of *y* with respect to *s* plus *y* times open bracket *one* plus *b* of *s* in parentheses, close bracket is equal to zero

$\int f(x)dx$ the integral of *f(x)* with respect to *x*

$\int_a^b f(x)dx$ the definite integral of *f(x)* with respect to *x* from *a* to *b* (between limits *a* and *b*)

$c(s) = K_{ab}$ *c* of *s* is equal to *K* sub *ab*

$x_{a-b} = c$ *x* sub *a* minus *b* is equal to *c*

$a \propto b$ *a* varies directly as *b*

28^o 28 degrees (angular measure and temperature measure)

56' 1) 56 minutes (angular measure); 2) 56 feet (linear measure)

45" 1) 45 seconds (angular measure); 2) 45 inches (linear measure)

$\sqrt{7}$ the square root (out) of 7

5% 5 per cent

2/9 % 1) two ninths per cent; 2) two ninths of one per cent

½ % 1) a half per cent; 2) a half of one per cent

0.47% 1) point four seven per cent; 2) zero point forty-seven per cent; 3) nought point forty-seven per cent; 4) o point four seven of one per cent

7 ‰ 7‰ seven per mille

$c = \frac{a}{b}$ *c* is equal to (dash, line of division) *a* over (divided by, by) *b*

<u>Note:</u> The words *dash* and *line of division* are often omitted.

c(a+b) 1) *c* parenthesis *a* plus *b* close parenthesis; 2) *c* round brackets opened *a* plus *b* round brackets closed;

3) *c* times (multiplied by) the quantity
a plus *b*

ПРИЛОЖЕНИЕ 8

Список слов иностранного происхождения с особыми формами образования множественного числа

analysis	analyses	анализ, -ы
apparatus	apparatus (-es, редко)	прибор, -ы
axis	axes	ось, оси
basis	bases	база, -ы, основание, -я
crisis	crises	кризис, -ы
criterion	criteria	критерий, -и
curriculum	curricula	программа, -ы
datum	data	данное, -ые
erratum	errata	опечатка, -и
foot	feet	нога, -и, фут, -ы
formula	formulae	формула, -ы
helix	helices	спираль, -и
index	indices	индекс, -ы
lamina	laminae	тонкий слой, тонкие слои
locus	loci	траектория, -и
maximum	maxima	максимум, -ы
medium	media	средство, -а
minimum	minima	минимум, -ы
phenomenon	phenomena	явление, -я
radius	radii	радиус, -ы
stimulus	stimuli	стимул, -ы
stratum	strata	слой,-и
terminus	termini	цель, -и
thesis	theses	тезис, -ы
tooth	teeth	зуб, -ы
vertex	vertices	геом. вершина, -ы

ПРИЛОЖЕНИЕ 9

Англо-русский политехнический словарь (вокабуляр)

A	
accelerate	ускорять
accord	1. согласие 2. соответствие, гармония 3. неофициальное соглашение 4. муз. аккорд, созвучие
acetic	уксусный
acetoacetate	1. соль ацетоуксусной кислоты 2. эфир ацетоуксусной кислоты
adjacent	1. примыкающий, смежный, соседний 2. мат. смежный
administer	1. управлять; вести дела 2. отправлять (правосудие); налагать (взыскание) 3.совершать (обряды) 4. снабжать; оказывать помощь 5. назначать, давать (лекарство)
affect	психол. Аффект 2. действовать; воздействовать; влиять 3. поражать (о болезни) 4. трогать, волновать 5. задевать, затрагивать 6. притворяться, делать вид, прикидываться 7. любить, предпочитать
again	1. снова, опять 2.с другой стороны; же 3. кроме того, к тому же
also	тоже, также, к тому же
antiknock	авто, ав. антидетонатор
appear	1.показываться; появляться 2. проявляться 3. явствовать 4. производить впечатление; казаться 5. выступать на сцене 6. выступать официально, публично 7. предстать (перед судом) 8. выходить, издаваться; появляться (в печати)
arise	1. возникать, появляться 2. проистекать, являться результатом
assume	допускать; предполагать
assumption	допущение, предположение
attempt	попытка
B	
Bond	связь; соединение; сцепление
butyl	1. бутил 2. бутил-каучук
C	
catalyst	катализатор
cause	1. причина 2. основание; мотив; повод 3.дело 4.юр. дело, процесс 5.быть причиной, причинять, вызывать 6.заставлять
citric	лимонный
concise	1.краткий; сжатый; немногословный 2.четкий; выразительный

confine	1. ограничивать 2.придерживаться (чего-либо)
conventional	1.обычный, общепринятый 2.приличный, светский; обусловленный; договоренный 3. условный 4. традиционный; шаблонный 5.тех. стандартный; удовлетворяющий техническим условиям
copper	1. медь || покрывать медью, омеднять|| медный 2. медное покрытие
corpuscle	1. частица, тельце; корпускула 2. физ. атом; электрон; корпускула
correlation	1. взаимосвязь, соотношение; корреляция; взаимозависимость 2. сопоставление 3. корреляционная функция
corrosion	коррозия; ржавление; разъедание; окисление
curve	1. кривая 2. изгиб; закругление; кривизна || изгибать (ся); закруглять (ся) 3. (характеристическая) кривая, характеристика; график; диаграмма 4. лекало 5.дор. разбивать кривую
cyclohexane	циклогексан
D	
degradation	1. деградация, ухудшение, снижение (физических свойств, параметров) 2. горн. Измельчение; дробление, размол 3. разрушение; деструкция; разложение 4 расщепление 5. потеря энергии (частиц) при столкновении
derive	1. выводить 2. мат. брать производную 3. мат. ответвлять
dimer	димер
distil	перегонять, дистиллировать
distortion	1. деформация 2. искривление; перекашивание; коробление 3. искажение; искажения 4. опт. дисторсия
drop	1. падение, снижение, понижение, спад || падать, снижаться, понижаться; спадать 2. перепад, градиент 3. эл. сброс (нагрузки) 4. гидр. перепад; водослив 5.капля || капать 6. падающий молот
E	
eliminate	удалять, устранять; исключать; элиминировать
elution	элюирование, извлечение из адсорбента, вымывание
eq.	уравнение
equation	1. уравнивание; выравнивание 2. уравнение 3.равенство
ester	сложный эфир
estimate	1. оценка || оценивать 2.приближенный расчет; предварительный расчет || рассчитывать 3. таксация (леса) || таксировать (лес
excess	1. избыток, излишек 2. мат. остаток

exert	действовать (о силе)
F	
ferrocene	ферроцен
fission	1. деление; расщепление 2. бтх фрагментация, поперечное деление
fluid	1. жидкость ‖ жидкий; жидкостный 2. текучая среда ‖ текучий 3.нефт. флюид (жидкость, газ, смесь жидкостей и газов) 4. газ ‖ газообразный
fusion	1. плавка; плавление; сплавление; оплавление 2. ванна жидкого металла; расплавленная масса; сплав 3. ядерный синтез 4. бтх встраивание; вставка 5.бтх, тлв слияние
G	
glacier	ледник
glucose	глюкоза; виноградный сахар; декстроза
H	
halide	галогенид; галоидное соединение; галоид
head	1. голова (например, дока, сваи) 2. головка (например, болта, заклепки, рельса); шляпка (гвоздя) 3. верхняя часть; верхний элемент (конструкции, аппарата) 4. передняя часть (конструкции) 5. головная часть (тоннеля) 6. штрек 7.мн. руда, поступающая на обогатительную фабрику 8. прибыль 9.наконечник (газовой или сварочной горелки) 10. насадка
I	
identify	1. идентифицировать; отождествлять 2. опознавать; распознавать 3.обозначать; маркировать
impurity	1. примесь; (постороннее) включение 2. загрязнение; грязь
indole	индол
inductive	индуктивный; проницаемый
inertia	инерция; сила инерции
be of interest	интересовать
intermediate	1. промежуточное химическое соединение; промежуточный продукт; полупродукт 2. промежуточное звено; промежуточная стадия ‖ промежуточный 3. текст. перегонная ровничная машина 4. полигр. дубликат оригинала на фотопленке; промежуточная форма; фотоформа
irradiation	1. излучение; испускание 2. облучение 3. энергетическая экспозиция (энергия излучения на единицу площади за определенный промежуток времени)
K	
Kcal	килокалория
L	

linkage	1. связь 2. соединение; сцепление 3.(химическая) связь; мостик 4. сбойка (скважин при подземной газификации) 5. рычажной механизм; рычажная передача 6. Эл. Потокосцепление; полный поток индукции 7. связь, установление [организация] связи
locus	1. местоположение 2. мат. геометрическое место точек 3. годограф 4.кривая 5.локус (положение гена или мутации на хромосоме)
loss	1. потеря 2.угар (металла) 3. затухание; ослабление 4. срыв (в следящих системах) 5. вчт проигрыш 6. ущерб; убыток
M	
monomer	мономер
N	
novel	новый
O	
occur	1.встречаться; попадаться 2. происходить; случаться; иметь место 3. залегать (о месторождении
P	
parent	1. физ. исходный элемент 2. вчт родитель, родительский [порождающий] элемент; родительская [порождающая] запись
potassium	калий
procedure	1. процедура; процесс; операция 2. порядок (действий) 3. метод; методика 4. алгоритм 5. правила; технология (технического обслуживания)
R	
ratio	1. отношение; соотношение; пропорция 2. коэффициент; степень; кратность 3. передаточное отношение 4. передаточное число
reaction	1. (химическая) реакция; 2. реакция; противодействие; обратное действие 3. ядерная реакция 4.положительная обратная связь 5. охр. Реакция организма на среду обитания
Reduction	1. уменьшение; снижение; сокращение; редукция 2. коэффициент вытяжки 3. обжатие
reestablished	восстанавливать
reflux	1.гидр. Отток; отлив 2.орошение (ректификационной колонны) 3. флегма
residue.	1.остаток 2. осадок; отстой; шлам 3. отходы 4. хим. радикал 5. мат. вычет
resonator	1. резонатор 2. реактивный глушитель выпуска дюз
roentgen	рентген
S	

secure	1. крепить; закреплять 2. мор. Задраивать 3. мор. Швартовать 4. гарантировать; обеспечивать 5. надежный; безопасный
sedimentation	осаждение; седиментация; отстаивание
sintering	1. агломерация; спекание 2. обжиг (руды) 3. мн. спеченные металлокерамические изделия
shift	1.замена; смена; изменение 2.перемещение; смещение; сдвиг перемещать; смещать; сдвигать 3. мет. перекос (дефект отливки) 4. переключение 6. авто отклонение (от заданного режима) 7. перевод (в телеграфии) 8. переключение [смена] регистров (клавиатуры пишущей машинки); вчт установка регистра (печатающего устройства) 9.(рабочая) смена
smooth	1. сглаживать; выравнивать 2. шлифовать; полировать
solid.	1. твердое тело 2. сухое вещество 3. массив 4. сплошной (о линии)
solvent	растворитель species 1. вид; разновидность 2. изотопы 3. биологический вид
split	щель; трещина; разрыв|| разрезать; прорезать 2.расслаиваться
T	
tar	1. гудрон || гудронировать 2. дёготь || пропитывать дегтем 3. смола || пропитывать смолой, смолить
technique	1. техника; методика; метод; способ 2. технология; технологический (прием) 3. алгоритм 4. оборудование; технические средства; техника
tertiary	Третичная обмотка
transient	1. переходное [неустановившееся] состояние; переходный [неустановившийся] процесс 2. переходный [неустановившийся] режим 3. неустановившийся ток 4. неустановившееся напряжение
V	
valence, valency	валентность
vapour(vapor)	1.пар (ы) || превращать (ся) в пар; испаряться 2. выпаривать
velocity	1. скорость 2.вектор скорости 3. быстродействие
vessel	1. сосуд; резервуар; баллон; контейнер (для жидкостей или газов) 2. судно 3. конвертер 4. реторта 5. ж.-д. цистерна 6. котел 7. гидросамолет
Y	
yield	1.добыча; дебит; извлечение; отдача || добывать; извлекать; отдавать 2.выпуск; производительность; выработка (например, электроэнергии); выход готовых (изделий) || производить; вырабатывать 3.полезная работа

	4.сток (например, водосброса) 5. отдавать (воду из водохранилища) 6. выход продуктов деления 7. вчт выдавать (значение) 8. коэффициент вторичной эмиссии (электронов) 9. осадка 10.улов (рыбы)

ГЛОССАРИЙ

Адаптивное транскодирование - вид языкового посредничества, при котором содержание оригинала передается в преобразованной форме, обеспечивающей заданный объем и характер передаваемой информации.

Адаптированный перевод - вид адаптивного транскодирования, при котором в процессе перевода осуществляется упрощение структуры и содержания оригинала с целью сделать текст перевода доступным для Рецепторов, не обладающих познаниями, которые требуются для полноценного понимания сообщения, содержащегося в оригинале.

Адекватный перевод - перевод, обеспечивающий прагматические задачи переводческого акта на максимально возможном для достижения этой цели уровне эквивалентности, не допуская нарушения норм и узуса ПЯ, соблюдая жанрово-стилистические требования к текстам данного типа и соответствия конвенциональной норме перевода. В нестрогом употреблении Ап. - это «правильный» перевод.

Антонимический перевод - лексико-грамматическая трансформация, при которой замена утвердительной формы в оригинале на отрицательную форму в переводе или, наоборот, отрицательной на утвердительную сопровождается заменой лексической единицы ИЯ на единицу ПЯ с противоположным значением. Безэквивалентная лексика - лексические единицы ИЯ, не имеющие регулярных (словарных) соответствий в ПЯ.

Безэквивалентные грамматические единицы - грамматические формы и структуры ИЯ, не имеющие однотипных соответствий в ПЯ.

Буквальный перевод - перевод, воспроизводящий коммуникативно нерелевантные элементы оригинала, в результате чего либо нарушаются нормы и узус ПЯ, либо оказывается искаженным (непереданным) действительное содержание оригинала.

Генерализация - лексико-семантическая замена единицы ИЯ, имеющей более узкое значение, единицей ПЯ с более широким значением.

Грамматическая замена - грамматическая трансформация, при которой грамматическая единица в оригинале преобразуется в единицу ПЯ с иным грамматическим значением.

Единица несоответствия - элемент содержания оригинала, не переданный или искаженный при переводе, или элемент содержания текста перевода, неправомерно добавленный при переводе.

Единица перевода.

1. Минимальная единица текста оригинала, которая переводится как единое целое, в том смысле, что ей можно отыскать соответствие в переводе, но нельзя обнаружить в переводе единиц ПЯ, воспроизводящих значение составных частей данной единицы, если таковые у нее имеются.

2. Единица переводческого процесса - минимальный отрезок текста оригинала, выступающий в качестве отдельной «порции» перевода, в том

смысле, что переводчик приступает к переводу каждого такого отрезка после завершения перевода отрезка предыдущего.

3. Единица эквивалентности - минимальная единица содержания оригинала, сохраняемая в переводе.

Единичное (постоянное) соответствие - наиболее устойчивый (постоянный) способ перевода данной единицы ИЯ, относительно независимый от контекста.

Жанрово-стилистическая классификация переводов - подразделение переводов в зависимости от жанрово-стилистических особенностей оригинала на художественный перевод и информативный перевод и функциональные подвиды перевода.

Жанрово-стилистическая норма перевода - требования, которым должен отвечать перевод в зависимости от принадлежности оригинала к определенному функциональному стилю.

Информативный перевод - перевод оригиналов, не принадлежащих к художественной литературе (общественно-политических, научно-технических, официально-деловых и пр.), т.е. текстов, основная функция которых заключается в сообщении каких-то сведений, а не в художественно-эстетическом воздействии на Рецептора.

Источник (информации) - создатель (автор) текста оригинала, отправитель сообщения.

Исходный язык (ИЯ) - язык оригинала, язык с которого делается перевод.

Калькирование - способ перевода лексической единицы оригинала путем замены ее составных частей - морфем или слов (в случае устойчивых словосочетаний) - их лексическими соответствиями в ПЯ.

Коммуникативная равноценность - способность текста выступать в качестве полноправной замены (в функциональном, содержательном и структурном отношении) другого текста. Коммуникативно равноценные тексты являются формами существования одного и того же сообщения и объединяются воедино (отождествляются) в процессе коммуникации.

Компенсация - способ перевода, при котором элементы смысла, утраченные при переводе единицы ИЯ в оригинале, передаются в тексте перевода каким-либо другим средством, причем необязательно в том же самом месте текста, что и в оригинале.

Конвенциональная норма перевода - требования, которым должен отвечать перевод в связи с общепринятыми в данный период взглядами на роль и задачи переводческой деятельности.

Конкретизация - лексико-семантическая замена единицы ИЯ, имеющей более широкое значение, единицей ПЯ с более узким значением.

Лексико-семантическая замена - способ перевода лексических единиц оригинала путем использования в переводе единиц ПЯ, значения которых не совпадают со значениями исходных единиц, но могут быть выведены из них с помощью логических преобразований определенного типа.

Лексический контекст - совокупность лексических единиц, в окружении которых используется данная единица текста.

Лингвистика перевода или лингвистическое переводоведение - раздел языкознания, изучающий перевод как лингвистическое явление.

Лингвистическая теория перевода - теоретическая часть лингвистики перевода.

Лингвистический контекст - языковое окружение, в котором употребляется данная единица языка в тексте.

Литературное переводоведение - раздел литературоведения, изучающий перевод как вид литературного творчества.

Межъязыковая (двуязычная) коммуникация - речевое общение между коммуникантами, пользующимися разными языками.

Множественное (вариантное) соответствие - один из регулярных способов перевода данной единицы ИЯ, частично воспроизводящей в ПЯ ее значение.

Модель перевода - условное описание ряда мыслительных операций, выполняя которые, можно осуществить процесс перевода всего оригинала или некоторой его части.

Модуляция (смысловое развитие) - лексико-семантическая замена слова или словосочетания ИЯ единицей ПЯ, значение которой является логическим следствием значения исходной единицы.

Норма перевода - совокупность требований, которым должен отвечать перевод.

Норма переводческой речи - требования, которым должен удовлетворять язык перевода.

Норма эквивалентности перевода - требование максимально возможной смысловой близости перевода к оригиналу.

Нулевой перевод - отказ от передачи в переводе значения грамматической единицы ИЯ, вследствие его избыточности.

Общая теория перевода - раздел лингвистической теории перевода, изучающий наиболее общие лингвистические закономерности перевода, независимо от особенностей конкретной пары языков, участвующих в процессе перевода, способа осуществления этого процесса и индивидуальных особенностей конкретного акта перевода.

Объединение предложений при переводе - способ перевода, при котором синтаксическая структура в оригинале преобразуется путем соединения двух простых предложений в одно сложное.

Однотипное соответствие - грамматическое соответствие в ПЯ, имеющее наименование, определение и грамматическое значение, аналогичное замещаемой единице ИЯ.

Окказиональное соответствие (контекстуальная замена) - нерегулярный, исключительный способ перевода единицы оригинала, пригодный лишь для данного контекста.

Официальный (готовый к опубликованию) перевод - окончательный вариант перевода, представляемый переводчиком в качестве полноценного воспроизведения оригинала.

Перевод - вид языкового посредничества, при котором содержание иноязычного текста оригинала передается на другой язык путем создания на этом языке коммуникативно равноценного текста.

Переводоведение - совокупность научных дисциплин, изучающих различные аспекты перевода.

Переводческая (межъязыковая) трансформация - преобразование, с помощью которого можно осуществить переход от единиц оригинала к единицам перевода. Переводческое соответствие - единица ПЯ, регулярно используемая для перевода данной единицы ИЯ.

Переводящий язык (ПЯ) - язык, на который делается перевод.

Письменный перевод - вид перевода, при котором оригинал и перевод выступают в процессе перевода в виде фиксированных (главным образом, письменных) текстов, к которым переводчик может неоднократно обращаться.

Прагматика перевода (прагматический аспект перевода) - влияние на ход и результат переводческого процесса необходимости воспроизвести прагматический потенциал оригинала и обеспечить желаемое воздействие на Рецептора перевода.

Прагматическая адаптация перевода - изменения, вносимые в текст перевода с целью добиться необходимой реакции со стороны конкретного Рецептора перевода.

Прагматическая норма перевода - требование обеспечения прагматической ценности перевода.

Прагматическая ценность перевода - степень соответствия текста перевода тем задачам, для решения которых был осуществлен процесс перевода.

Прагматический потенциал текста - способность текста оказывать воздействие на Рецептора, вызывать у него интеллектуальную или эмоциональную реакцию на передаваемое сообщение.

Приближенный перевод - использование в переводе грамматической единицы ПЯ, которая в данном контексте частично соответствует безэквивалентной грамматической единице ИЯ.

Прием лексических добавлений - использование в переводе дополнительных лексических единиц для передачи имплицитных элементов смысла оригинала.

Прием местоименного повтора - повторное указание в тексте перевода на уже упоминавшийся объект с заменой его имени на соответствующее местоимение.

Прием опущения - отказ от передачи в переводе семантически избыточных слов, значения которых нерелевантны или легко восстанавливаются в контексте.

Прием перемещения лексических единиц - использование ближайшего соответствия переводимой единице ИЯ в другом месте высказывания в тексте перевода.

Прием пословного перевода - подстановка ближайших соответствий вместо лексических единиц оригинала при сохранении синтаксических связей между ними в качестве промежуточной стадии в процессе поиска оптимального варианта перевода.

Процесс перевода (собственно перевод) - действия переводчика по созданию текста перевода.

Психолингвистическая классификация переводов - подразделение переводов на виды и подвиды по способу (речевой форме) восприятия оригинала и создания текста перевода.

Рабочий перевод - предварительный перевод, эквивалентность которого ограничена лишь передачей на уровне способа описания ситуации предметно-логического содержания оригинала.

Разнотипное соответствие - грамматическое соответствие в ПЯ, не совпадающее с исходной единицей по названию и определению.

Рецептор (информации) - получатель сообщения, слушающий или читающий участник коммуникации.

Свободный (вольный) перевод - перевод, выполненный на более низком уровне эквивалентности, чем тот, которого можно достичь при данных условиях переводческого акта.

Синтаксический контекст - синтаксическая структура, в рамках которой употреблено данное слово в тексте.

Синтаксическое уподобление (дословный перевод) - способ перевода, при котором синтаксическая структура оригинала преобразуется в аналогичную структуру ПЯ с сохранением набора полнозначных слов и порядка их расположения в оригинале и переводе.

Ситуативная модель перевода - модель перевода, представляющая процесс перевода как процесс описания при помощи ПЯ той же ситуации, которая описана в оригинале.

Ситуативный (экстралингвистический) контекст - обстановка, время и место, к которым относится высказывание, а также любые факты реальной действительности, знание которых помогает Рецептору правильно интерпретировать значения языковых единиц в высказывании.

Ситуация - совокупность идеальных или материальных объектов и, связей между ними, описываемых в содержании высказывания.

Смысловая доминанта - наиболее важная часть содержания оригинала, которая должна быть непременно сохранена в переводе и ради сохранения которой могут быть принесены в жертву другие элементы переводимого сообщения.

Сокращенный перевод - перевод, при котором осуществляется опущение отдельных частей оригинала по моральным, политическим или иным соображениям практического характера.

Сопоставительный анализ перевода - анализ формы и содержания текста перевода в сопоставлении с формой и содержанием оригинала.

Специальная теория перевода - раздел лингвистической теории перевода, изучающий особенности процесса перевода текстов разного типа и влияние на этот процесс речевых форм и условий его осуществления.

Способ описания ситуации - часть содержания высказывания, указывающая на признаки ситуации, через которые она отражается в высказывании.

Точный перевод - перевод, в котором эквивалентно воспроизведена лишь предметно-логическая часть содержания оригинала при возможных отклонениях от жанрово-стилистической нормы и узуальных правил употребления ПЯ.

Транскрипция - способ перевода лексической единицы оригинала путем воссоздания ее звуковой формы с помощью букв ПЯ.

Транслитерация - способ перевода лексической единицы оригинала путем воссоздания ее графической формы с помощью букв ПЯ.

Трансформационно-семантическая модель перевода - модель перевода, представляющая процесс перевода как ряд преобразований, с помощью которых переводчик переходит от единиц ИЯ к единицам ПЯ.

Трансформационный перевод - перевод с использованием одной из переводческих трансформаций.

Узкий контекст (микроконтекст) - лингвистический контекст в пределах одного словосочетания или предложения.

Уровень (тип) эквивалентности - степень смысловой близости оригинала и перевода, определяемая частью содержания оригинала, сохраняемой при переводе.

Устный перевод - вид перевода, при котором оригинал и его перевод выступают в процессе перевода в нефиксированной (устной) форме, что предопределяет однократность восприятия переводчиком отрезков оригинала и невозможность последующего сопоставления или исправления перевода после его выполнения.

Художественный перевод - перевод произведений художественной литературы, Т.е. текстов, основная функция которых заключается в художественно-эстетическом воздействии на читателя.

Цель коммуникации - часть содержания текста (высказывания), указывающая на общую речевую функцию текста в акте коммуникации.

Частная теория перевода - раздел лингвистической теории перевода, изучающий лингвистические аспекты перевода с одного данного языка на другой данный язык.

Черновой перевод - предварительный перевод, эквивалентность которого ограничена лишь передачей на уровне указания на ситуацию предметно-логического содержания оригинала при возможных пропусках и отклонениях от нормы ПЯ.

Членение предложения - способ перевода, при котором синтаксическая структура предложения в оригинале преобразуется в две или более предикативные структуры в ПЯ.

Широкий контекст (макроконтекст) - лингвистический контекст, выходящий за пределы предложения, в котором употреблена данная языковая единица.

Эквивалентность перевода - общность содержания (смысловая близость) оригинала и перевода.

Эквивалентный перевод - перевод, воспроизводящий содержание оригинала на одном из уровней эквивалентности.

Экспликация (описательный перевод) - лексико-грамматическая трансформация, при которой лексическая единица ИЯ заменяется словосочетанием, эксплицирующим ее значение, т.е. дающим более или менее полное объяснение этого значения на ПЯ.

Этап переводческого процесса - часть переводческого процесса, характеризуемая действиями переводчика определенного типа.

Языковое посредничество - преобразование в процессе межъязыковой коммуникации исходного сообщения в такую языковую форму, которая может быть воспринята Рецептором, не владеющим ИЯ.

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